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ENGINEERING AND MINING JOURNAL-PRESS

A CONSOLIDATION OF ENGINEERING AND MINING JOURNAL AND MINING AND SCIENTIFIC PRESS

Underground Blasting in Metal Mines with Liquid Oxygen Explosives, by G. St. J. Perrott

Closed Circuit Grinding at the Lake Shore Mines, by H. W. Shoemaker

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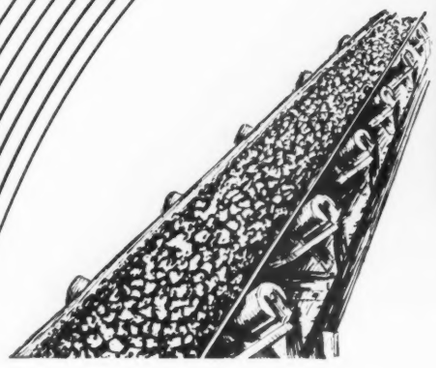

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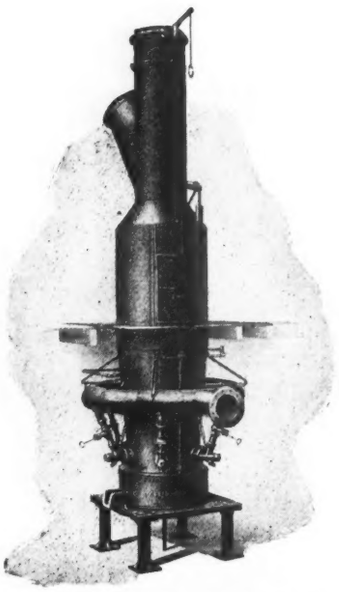
Water Jacketed Blast Furnaces for Copper and Lead Ores



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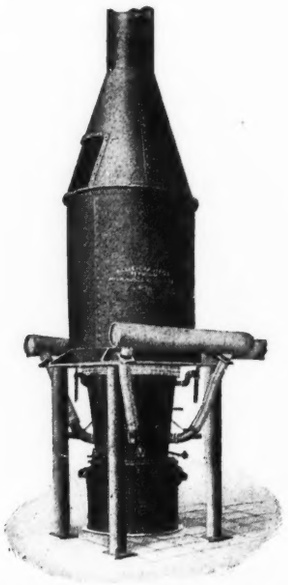

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ENGINEERING AND
MINING JOURNAL-PRESS

JOSIAH EDWARD SPURR, Editor

Volume 121 New York, February 27, 1926 *Number* 9

American Jingoes and Mexico

WHETHER newspapers help or hurt civilization is a problem which might well serve as a question for many high-school debates. Most of us derive our information and our opinions from the newspapers, which information we accept at its face value till it chances to deal with a subject on which we happen to be expert: then, in the majority of cases, we find that this particular information is garbled and entirely misleading. Then we have a moment of questioning as to whether all the stuff on other subjects which we have swallowed has been equally wretched. And after this glimmer of somewhat strenuous thought, we go back to the perusal of our newspaper.

These reflections—which are habitual—are evoked on reading inflammatory headlines and text in the *New York Herald Tribune* of Feb. 18: "Mexico's War on Churches Stirs Demand U. S. Intervene. Religious Protest So Pressing That Action Seems Nearer Than at Any Time Since Villa Expedition." The article was written by one Carter Field, a Washington correspondent.

This is the kind of inflammatory publicity which does harm to American interests in Mexico and keeps the people and the government of Mexico in suspicion and fear of the marching of armed troops into their capital and the shelling of their seaports, in order that what they believe to be the desire of special foreign interests for greater domination and profit may be satisfied. And this stimulates the Mexican Government to further precautionary measures against this campaign of intimidation, and to further plans to retain the independence, commercial, social, and political, of the Republic of Mexico.

What special corporate and religious interests lie behind the particular journalistic outburst which has furnished the theme of this editorial we will not take pains to inquire. One of the shocking pieces of anti-Mexican news published as a tailpiece to Mr. Field's article is this: "Mexican school teachers have been ordered to stay out of politics or quit teaching. Dr. J. M. Puig Casauranc, Minister of Education, has circularized all teachers, requesting their resignations if they intend to become candidates for any public office."

What an outrage! Dispatch armed American troops at once to take charge of the Mexican Department of Education, and shoot 'em up if they block the road! And court-martial anyone who calls attention to the fact that this ruling is a wise and sensible one, and is in general use in the United States. Why compare Mexico with the United States, the impeccable?

The separation of Church and State was one of the essentials to modern free government. It is one of the cardinal principles of the American republic, and it was accomplished by country after country in Europe until all of them, including France, under Napoleon, and Italy in 1870, attained independence and toleration. Mexico accomplished this in 1859, the patriot Benito Juarez introducing a constitution largely modeled on that of the United States. Subsequent measures to insure freedom of domination of the State by the Church, which Mexico has felt impelled to take, are paralleled by measures which France and Italy have taken for the same purpose, and some quite recently. Yet no jingoistic congressman, impelled by religious fervor, proposes a punitive expedition into France. The reason is obvious; and the reputation of the United States, south of the border, for harboring bullying legislators, is confirmed.

Engineering and Mining Journal-Press recently sent one of its staff into Mexico to report what he saw and what Americans and other foreigners in Mexico thought of the political and commercial situation. His mission was to report what he saw, regardless of which way the chips flew. His article, which appeared in the issue of Feb. 13, 1926, is to be recommended as an impartial reflection of what seems to be the consensus of opinion of honest men in Mexico. That opinion, and the article reflecting it, is constructive, and will make toward a better understanding on both sides of the border, mutual helpfulness, and greater progress, which, it must be explained, will involve greater commercial profit.

Mass Production the Basis of Low Costs

GERMANY has long been known to be a leader in thoroughness of detail and in efficiency of production. In the utilization of byproducts she has been unsurpassed. In reforestation of denuded woodland she has taken the lead. However, judging from a late report to the U. S. Department of Commerce, she is far behind the American manufacturer of automobiles. Her industry in this line is small, producing only 30,000 automobiles per year, with 300,000 men employed. Using these figures as a basis, it takes ten workmen one year to produce one automobile and the necessary parts to keep it in running order, while in the American industry each workman produces more than one car per year. In this country the automobile industry is expanding. In 1924 the total number of machines produced was 3,144,999 passenger cars and 359,868 trucks; in 1925 there was produced 3,678,327 passenger cars and 474,923 trucks. Even a greater production is anticipated in 1926.

It is doubtful whether in any industry in this country has efficiency reached such a high degree of perfection as in the manufacture of automobiles, nor has any industry progressed so rapidly as has this one by reason of mass production.

In Germany this industry, by reason of foreign competition, is shrinking. Since the embargo was lifted in October, and a heavy duty substituted, American agencies immediately sprang up throughout the country and consistently undersold the German product.

Now comes the announcement that there is a movement on foot in Germany to pool all the plants, standardize the operations, and adopt a single type of auto-

mobile, in the manufacture of which all will participate. Each firm would devote all its time and energy exclusively to the production of a single part, with the hope that the assembled car will cost less than the American car. Here again is German efficiency asserting itself. Mass production of single parts seems to be the motto, as in America.

Attention to Petroleum

PETROLEUM is a much-talked-about commodity these days. The fact of its importance registers itself in many ways. It was very much talked about at the New York meeting of the American Institute of Mining and Metallurgical Engineers held last week. In fact, the sessions of the Petroleum Section constituted an oil convention in themselves. Over fifty papers were presented and many of them discussed. The survey thus given of the industry was world-wide in its scope. The spirit of the sessions and the ability of those in charge of the program to obtain so many papers indicates a keen interest in the situation in which the industry finds itself on the part of those engaged in it. Less than a month before, the American Petroleum Institute had held its annual meeting, in Los Angeles, which drew over 1,500 delegates. In between the two meetings came the public hearings on Feb. 10 and 11 by the Federal Oil Conservation Board at Washington, which were well attended. Petroleum men evidently have something on their mind, and with good reason.

In the year just passed, production in the United States increased by about 50,000,000 bbl., reaching a new high peak, though at the beginning of 1925 a decline in production and withdrawal of oil from storage had been earnestly hoped for. The output was 764,000,000 bbl., according to figures just issued by the Bureau of Mines, which correspond closely to the estimate of 763,500,000 bbl. made by *Mining Journal-Press* early in November. Once again the industry is hoping for a decline in output, and a decline is certain unless a new bonanza pool is found. But just as new deep production was unexpectedly developed in the Smackover field, in Arkansas, last year, so expectations and hopes may again fail of realization. Meanwhile, oil production continues at a high, though declining, rate; methods of development are alleged to be wasteful, and debatable remedies are proposed; the Federal Government is investigating the situation, and since its interest is for the common good, and not for the producers alone, the latter have visions of Federal interference, whatever it may mean. Hence their evident uneasiness.

The producers are not be censured for disliking the idea of intervention or supervision by the government: there is much wisdom in the slogan "Less government in business." But certainly nothing is to be gained by refusing to admit facts that are well established; neither does it seem good sense to plunge heedlessly ahead in a race for new production, with the reckless excuse that if the supply of oil run short, science will curtail the demand for it by developing new substitutes. Yet the Committee of Eleven of the American Petroleum Institute—all of them leaders in the industry—has said precisely that. One hesitates to charge these prominent men with mere stupidity. Blind optimism in business is stupid. But if not stupidity, it is insincerity; and which is worse? The effort to have a lawyer, Ex-Secretary Hughes, represent the Institute before the Oil Conservation Board looks like an attempt to resort to legal juggling, with all due respect for Mr. Hughes.

The proposal that new pools be developed as a unit without regard to property lines has much to recommend it, though to work out a plan that would put it into effect, in a way satisfactory to the majority of the owners, would doubtless be very difficult. What happens when a new pool is found on property belonging to several owners is too well known to need repeating. The resulting production can scarcely be said to be produced as and when the operating companies want it. Each company strives to get the largest share it can, lest a neighbor get it. Thus a wild scramble ensues without regard for the condition of the market. This is what happened in the Smackover field last year—as in many another field. It was Smackover's greatly increased production that caused the new peak in the country's output in 1925. Yet one of the speakers at the A.I.M.E. petroleum sessions did not hesitate to say that "the development of the Smackover field is in the hands of none but experienced oil men." "Experienced" he should have said, meant "experienced in the wasteful methods of drilling and development prevalent in the industry." He was properly criticized by one who said that the Smackover production had been brought in as nature wanted it and obviously without any control by the "experienced" oil men.

There is an evident lack of sense of responsibility on the part of most operators toward their fellow operators in the matter of drilling and development. It is entirely natural. But just as the natural man is uncivilized and requires training, so this natural situation needs correcting for the general good. If the operators cannot correct it of their own accord—and, indeed, this will be difficult—it may be necessary to seek government aid.

Earnings Not Always Dividends

THAT EXCELLENT EARNINGS are not always reflected in correspondingly liberal dividends is a fact that is sometimes forgotten by the investor in mining as well as in other kinds of stocks. Brokers often tempt purchasers by pointing out the extraordinary profits that a company is making, whereas the dividend yield may be anything but attractive. An instance is the United States Steel Corporation, which the *Wall Street Journal* believes had little justification for setting aside $25,000,000 of its 1925 profits rather than to increase its dividend above the $1.75 per quarter rate that it has maintained for two years. But this is no new policy for the Steel Corporation, which has poured a large amount of money from profits into surplus and into funds for improving its existing plants and adding others. The names of other companies come to mind whose regular rates of dividend bear no evident relation to the current earnings. There is the Consolidated Mining & Smelting Co. of Canada, for instance, whose regular rate of dividend is only $3 per year, though earnings have been running several times that figure. A part of the excess was distributed in a special bonus of $5 per share paid last month, but it would be preferable from the stockholders' viewpoint to add a proportion of the surplus earnings to the regu-

lar dividend, so long as such excess profits continue. They would then know better what to expect in the way of a yield on their investment.

To establish regular dividends, which may be paid in good times and bad, is a laudable ambition and makes for comparatively narrow fluctuations in security prices and for increased stability. Buyers of securities would do well to give more consideration to the policies of companies in distributing their earnings, and not be guided entirely by present and potential profits which may be reserved for the dim future.

Long Shots

SPECULATION in mining ventures—even those of the most hazardous kind—can be intelligent or unintelligent. If a man wants to play a long shot, he is justified in risking $100 if the possible return is $1,000 or $10,000, but he would be foolish if the best he could do was to double his money. It is assumed of course that the status of the enterprise is such that the chance of recovering the original $100 is slim.

Opponents of "blue-sky" legislation argue that bold chance-takers of a generation ago opened the mines of the West; that if they had not had the nerve to risk their money the mineral resources of the country would never have been developed. Grant that. They contend that more money is needed to open more new properties, and that the portion of the public that feels the desire to do a little honest gambling in mines should have the opportunity. Grant that.

Now, imagine a first-class gold prospect. The showing is good; some ore is developed; enough, perhaps, to warrant the erection of a small mill which some day may be enlarged if development continues to be satisfactory. Conceivably, dividends may be paid, and it is not impossible that a mine rivaling the biggest and richest in the history of gold mining may be developed. If it should ultimately produce $200,000,000 and pay $50,000,000 in dividends in the course of fifty years the prospect would be worth $10,000,000 at the beginning of the period. There probably is not one chance in a thousand that such a rosy career lies ahead of the prospect, but for the sake of the argument suppose that the chance were 1 in 100. Assume that the company that is developing the property has issued 2,000,000 shares of capital stock.

If the mine becomes an enormous success, if the unexpected happens, then the owner of one share of stock will, in effect, realize $5 including his investment. If the chance of this happy eventuality is 1 in 100—and the most unreasoning optimist knows better—he would be justified in paying 5c. per share for the stock. If he pays 25c. he lays about 1 to 10 where the odds are 1 to 100; if he pays $1.25 he lays about 1 to 3 where the odds are 1 to 100. Yet millions of shares of mining stock are sold every year for prices no less unwarranted on the basis of mathematical probability.

There is, of course, the feature of stock-market trading. In an active market the buyer of shares has the opportunity to realize a small profit from possible enhancement in the price on the exchange, but there should be intrinsic value behind the shares. Otherwise, the ultimate buyer is sure to be a loser. It matters little whether the stock passes through a dozen hands, leaving a little profit at each stage, to the man who finally holds it, if the "mine" proves a failure.

Of course a few years' development may prove that the mine will be a profitable producer at least on a moderate scale. Then the shares easily may be worth $1.25 or considerably more. The value, then, is twofold: the assured worth of developed ore, which promises a moderate return, and the speculative worth of new ore deposits that conceivably may make one of the world's big mines.

Mining Journal-Press has no desire to discourage speculation in young mining properties by those who know what they are doing, but it does advise buyers of shares in highly speculative enterprises to see that the price they pay gives them a chance to make a profit in some degree commensurate with the risk of losing the original outlay.

An Outlet for Surplus Profits

DURING THE CURRENT YEAR, many capitalists—and who is not, more or less, a capitalist?—will be seeking new investments for their money. It is fairly certain that security prices are well above normal, and the time would seem to be ripe or ripening for the conservative investor to market his more volatile common stocks. This brings up the question as to what to do with the money thus gained. Most of it will no doubt go into bonds and mortgages, and some into real estate, though real estate itself has been experiencing more or less of a boom lately and is therefore not so attractive for present funds. Why not use a little of one's surplus in an effort to find some attractive mining prospect and develop it? This is not meant as a suggestion to buy some of the mining stocks of more or less doubtful value which are so freely dealt in on the lesser stock exchanges of the country, for money so invested often does little or nothing toward the development of the mine in question. To get even as far as having its stock quoted, a mine owner must usually share liberally with the promoter. But what is suggested, is to seek out the honest owner of a deserving prospect who has not the money to do justice to his claim.

The names of those deserving of such help are not hard to obtain. Any engineer whose work takes him into the field usually knows a few, and the manager of any large operating property generally knows what prospectors are doing in his immediate district. The heads of the various mining schools, directors of the state bureaus of mines and geology, and of the various branches of the federal Bureau of Mines, all know of mining prospects that will bear investigation and development, or, in other words, which warrant the spending of money.

Scouts of the large companies are likely to be ultra conservative. Many small mines have come into the ranks of the money-makers in the last few years that were passed up by the large interests. Several companies whose present stock-market valuation is from ten to twenty million dollars each come to mind as examples. There are more such waiting only for the breath of life from funds that are now or soon will be looking for a new roosting place. If most of one's money is safely invested in good bonds, a small speculation in some deserving mine (not mining stock) would seem to be a wise move. Ore deposits can be found just as easily in a declining stock market as in an advancing one.

Underground Blasting in Metal Mines With Liquid Oxygen Explosives

Experiments at Leadville, Pachuca, and Cerro de Pasco Indicate a Possible Field —Production of CO and SO_2, Flammability of Cartridges, and Other Factors Place Limitations on Use

By G. St. J. Perrott*

Assistant Chief Explosives Chemist, Pittsburgh Experiment Station, Bureau of Mines

G. St. J. Perrott

ACCORDING to Rice,[1] liquid oxygen explosives, commonly called "L.O.X." were first tried in Germany in 1895 in a crosscut of the Penzberg coal mine, in upper Bavaria. The first important trials were made in driving the 12-mile Simplon tunnel between Italy and Switzerland, where favorable results were said to have been obtained, but the use of L.O.X. was discontinued following the death of the engineer in charge of experimental work. Little further work was done until the beginning of the World War, when the need for conserving glycerin and nitrates forced Germany to look for substitutes for these materials for use in industrial explosives. By 1917, a total of 160 coal, metal, salt, and potash mines were using L.O.X., where plants had a total hourly capacity of 4,860 liters.[2]

The scarcity and high price of ordinary explosives during the war caused the U. S. Bureau of Mines to investigate the possibilities of L.O.X. In 1921, the installation of a 25-liter oxygen plant at Pachuca, Mexico, by the U. S. Smelting, Refining & Mining Co., and the use of L.O.X. there, resulted in considerable improvement in the technique of blasting with L.O.X. and in the reduction of cost obtained under actual working conditions. Later, the Ingersoll-Rand and Air Reduction companies carried out considerable work both underground and in quarrying operations, and the Purox Company, of Denver, Colo., carried on experimental blasting at Leadville, Colo., and Birmingham, Ala. The Cerro de Pasco Copper Corporation has recently installed a plant at its mines at Cerro de Pasco, Peru.

During the last two years the Bureau of Mines has made an intensive investigation of L.O.X. with the purpose of determining the factors governing its explosive properties and applying this knowledge to the use of the explosive in actual blasting. (It should be stated here that the Bureau has not approved of L.O.X. for coal mines, because the flame of most L.O.X. cartridges is of such duration and temperature as to cause explosions in gaseous or dusty mines, and because of the danger of fires or explosions through accidental spilling of liquid oxygen on coal dust in the mine and subsequent ignition of the mixture.) Laboratory investigations, which included a study of the properties of typical combustibles used in L.O.X. and the relation of these properties to explosive characteristics, have already been described.[3] Through the courtesy of the Purox Company, the United States Smelting, Refining & Mining Co., and the Cerro de Pasco Copper Corporation, results that I obtained during the course of experimental blasting at Leadville, Pachuca, and Cerro de Pasco are given in this paper.

Nature of Liquid-Oxygen Explosive

The L.O.X. cartridge consists of a paper wrapper packed with an absorbent combustible material such as lampblack. Before use the cartridges are saturated with liquid oxygen by soaking in a vacuum-walled container. After saturation they are removed from the container and detonated with fuse and detonator or electric detonators in a manner similar to ordinary dynamite.

Because of the low temperature (—183 deg. C.) of liquid oxygen, a large temperature difference exists between the cartridge and its surroundings, and evaporation of oxygen begins the instant the cartridges are removed from the liquid. This gives rise to both advantages and disadvantages—advantages in that the cartridge is harmless before soaking and thirty to forty minutes after removal from the liquid, and disadvantages in that the explosive strength diminishes as the oxygen evaporates, and if the round is fired after a certain time the gases produced contain increasing percentages of carbon monoxide.

Life of the L.O.X. Cartridge Limited

The life, or available life, of a liquid-oxygen cartridge is usually defined as the time in minutes that elapses from the instant the cartridge is removed from the liquid to the instant at which just sufficient oxygen remains for complete combustion to carbon dioxide, CO_2. The cartridge may be explosive for a considerable time thereafter, but will produce increasing quantities of carbon monoxide when it is fired.

Considerable more or less empirical research has been conducted for the purpose of finding materials

*Published with approval of the Director, U. S. Bureau of Mines, Department of Commerce.

[1]Rice, G. S., "Development of Liquid-oxygen Explosives During the War." U. S. Bureau of Mines Technical Paper 243, 1920, 46 pages.

[2]Pabst, Richard: "Flüssiger Sauerstoff und sein Verwendung als Sprengstoff im Bergbau." Munich and Berlin, 1917.

[3]Perrott, G. St. J.: "Properties of Liquid Oxygen Explosives." Preprint 1338A. *Trans.* A.I.M.E., Feb., 1925.

Mining Engineers of Note

Dwight Edwards Woodbridge

THE CHARGE that engineers do not display a sufficient interest in public affairs cannot be made against Dwight E. Woodbridge, of Duluth. Mr. Woodbridge has long been associated with the development of the Lake Superior iron country in various technical capacities. Yet he has found it possible to devote a considerable portion of his time to the furtherance of the interests of the city in which he makes his home and of which he has been a resident for the greater part of his life. For several years he has been a director of the Duluth Chamber of Commerce and at one time he was its vice-president. Another important organization in Duluth is the City Planning Commission. Duluth is a long narrow city, winding its way along the steeply sloping shore of Lake Superior. Owing to the topography, traffic is concentrated heavily in certain streets, and for this and other reasons it seemed advisable four years ago to create a City Planning Commission. On this body Mr. Woodbridge has served since its organization, and he is now in his third year as its president. The scope of his activity in this direction has widened, for he was later asked to serve on the Engineering Council's National Committee on City Planning. He has also served on a committee named by the Engineers Club of Duluth to iron out certain differences between the city and the street railway companies, which succeeded in working out what is regarded as an ideal franchise by those skilled in street railway transportation matters. Likewise, he has devoted time to service on the Minnesota State Board of Registration for Engineers, Architects, and Land Surveyors. Mr. Woodbridge ran for Mayor in the last election, and although fortune went against him he nevertheless made an excellent showing at the polls. It was in 1898 that Mr. Woodbridge began his career as a mining engineer in Duluth. He had graduated eleven years before, at the age of twenty-two, from Carleton College, at Northfield, Minn. For several years he was consulting engineer to the U. S. Bureau of Mines, in charge of all iron-mining investigations. His work as consultant has taken him into many parts of the world and he naturally has acquired a highly specialized knowledge of all matters pertaining to iron-ore mining. When the disaster occurred last spring at the Milford mine, on the Cuyuna Range, he was appointed on the commission created by the Governor to investigate the accident and make recommendations as to mine inspection laws. For a long time Mr. Woodbridge has been interested, both as an engineer and financially, in the concentration of lean iron ores. Thus he has familiarized himself with what is steadily becoming a more and more important problem of the iron industry of today. He has been active in the venture to develop a large deposit of lean, magnetic iron ore on the Mattewin range, in the Lake Superior district of Ontario. All the work done thus far on this property and all the estimates made are credited to him, in his capacity as technical adviser in the project. Mr. Woodbridge is a member of the American Institute of Mining and Metallurgical Engineers, the American Iron and Steel Institute, and the Lake Superior Mining Institute. He has contributed numerous technical papers to the proceedings of these bodies and to the technical press. While with the Bureau of Mines he prepared "Sanitation at Mining Villages in the Birmingham, Ala., District," and "Mine Accident Prevention at Lake Superior Iron Mines." He is a New Englander by birth, having been born in Newton, Mass., the son of Jonathan Edwards Woodbridge and Lydia Judkins. In 1890 he married Mary Munger, of Duluth, and has two children, a daughter, and a son, Roger Woodbridge, who is the representative, in the Lake Superior iron country, of a large mining machinery house.

DWIGHT EDWARDS WOODBRIDGE

Mr. Woodbridge spends considerable time outdoors and is fond of camping in the wilderness without trail or guides. He has established a record at canoeing that he is proud of, having traveled 280 miles in fifty-two hours' total time, including sleep and meals. Those who choose to dispute this title with him can readily get in touch with him at his office in the Sellwood Building, in Duluth.

as feasible—for example: a 1¼-in. cartridge, density 0.32, fired after ten minutes' evaporation has a strength equal to 1.25 sticks (1¼ in. x 8 in.) of 40 per cent gelatin dynamite; a 1½-in. cartridge under similar conditions equals two sticks of dynamite. It can also be shown that the 1½-in. cartridge has a strength, volume for volume, equal to 92 per cent that of dynamite, and that the 1¼-in. cartridge has a strength 83 per cent that of dynamite. If fired in five minutes, one L.O.X. cartridge, 1½x12 in., is equivalent to 2.25 sticks of dynamite, or is 110 per cent the strength of dynamite on a volume basis; the 1¼x12-in. L.O.X. cartridge equals 1.42 sticks of dynamite, or 95 per cent the strength of dynamite on a volume basis.

The curves also show the increase of explosive strength with density. For example: A 1½-in. cartridge, density 0.26 g. per cubic centimeter, fired in five minutes, has a strength equal to 1.95 sticks (1¼x8 in.) of 40 per cent gelatin dynamite; under similar conditions a 1½-in. cartridge, density 0.32 g. per cubic centimeter, has a strength equal to 2.25 sticks of dynamite, or 15.5 per cent greater strength. On the other hand, the lighter cartridge has a life of eleven minutes as against five and a half minutes for the heavier cartridge.

Table I—Relation Between Oxygen Content of Cartridge and Explosive Strength

Grams of Oxygen per Gram of Cartridge	Grams of 40 Per Cent Gelatin Dynamite Equal to 1 G. Dry L.O.X. Cartridge (Before Soaking)
3.0	5.7
2.5	5.2
2.0	4.7
1.5	4.0
1.0	3.3

From the data in Table I the explosive strength of any lampblack cartridge fired after any given time of evaporation may be approximately calculated from the data of a simple evaporation test. For example:

An L.O.X. cartridge, sixe 1⅜x12 in., dry weight 95 g., weighed 267 g. after ten minutes' evaporation. The explosive strength, if detonated at this instant, is calculated as follows: Oxygen ratio $= \frac{267 - 95}{95}$ $= 1.81$. From Table I, at this ratio, 4.4 g. of dynamite = 1 g. of dry L.O.X. cartridge, and as a stick of 40 per cent dynamite weighs 250 g., one stick of L.O.X. of above size, fired in ten minutes, is equivalent in explosive strength to $\frac{95 \times 44}{250} = 1.7$ sticks (1¼x8 in.) of dynamite.

Suggestions for Underground Blasting by L.O.X.

In the use of L.O.X. for underground blasting in metal mines the importance of the following facts and methods of procedure has been established:

1. Use cartridges of as large diameter as can be easily pushed to the bottom of the borehole to obtain greatest explosive strength and minimum formation of CO.

2. Fire the round as quickly as possible for greatest explosive strength and minimum formation of CO. Cartridges begin to lose oxygen and explosive strength the instant they are removed from the soaking container. There is no ideal moment at which cartridges have maximum strength other than the moment they are removed from the liquid.

3. For greatest efficiency and safety, use electric delay-action detonators of such character that the spit of the ignition element or fuse will not ignite the explosive. If fuse must be employed use fireproof fuse, and one whose rate of burning is unaffected by contact with the explosive. Ordinary fuse may, in a measure, be fireproofed by smearing with wet clay or whitewash immediately before using.

4. Use plenty of stemming, at least 20 in. per hole. Stemming for L.O.X. may be moist clay wrapped in paper or fine dry muck in tamping bags. It may be pushed tightly into the hole without preventing the escape of evaporating oxygen.

5. The lighter the density of a given cartridge the longer will be its life of evaporation before the production of large quantities of CO when detonated. However, the explosive strength of a cartridge increases up to a certain limit as the packing density is increased, and when maximum strength is essential a certain amount of CO may be permitted in well-ventilated workings in return for the better breaking effect of cartridges of high density.

6. Gas-black or lampblack have been found to be the best material for L.O.X. cartridges. In general, patent mixtures of carbene, aluminum, cork dust, and similar material lose oxygen more rapidly and produce more CO for a given explosive effect and time of evaporation than do lampblack cartridges.

Electric Firing Fuse and Caps

In most blasting operations electric firing has a distinct advantage over fuse and cap because of the increased safety and efficiency. With L.O.X. there are still further advantages of safety and efficiency by electric firing, as follows: (1) The outer covering of ordinary fuse tends to burn in the oxygen vapor at the face and may burn into the hole and cause a detonation. (2) Some fuses are liable to side-spit and, if this takes place in the hole, ignition of the cartridges and premature detonation may take place. (3) For greatest speed in loading it is best that fuse and cap be placed in the hole before loading is begun. Depending upon the depth of the hole, this means that a period of four to seven minutes must elapse after cartridges are loaded and before detonation, during which cartridges are rapidly losing strength. (4) Many varieties of fuse at the temperature of liquid oxygen burn at a slower rate than at normal temperature. In a borehole loaded with L.O.X. the fuse is at a temperature which depends on the number of cartridges, how tightly they press the fuse, and time of contact, and this varies from hole to hole. Furthermore, in holes tightly tamped there may be sufficient pressure built up to affect the burning rate. Hence timing in L.O.X. rounds is likely to be erratic.

Modification of Delay-Action Electric Detonators Often Necessary for L.O.X.

If an L.O.X. round is fired with ordinary delay-action electric detonators, all of the holes are likely to go at the same instant, or at any rate the timing will be very erratic. This is due to the fact that the initial spit of this device, which occurs when the electrical circuit is closed, lights the flammable L.O.X. cartridges, which in turn set off the cap and detonate the hole. This difficulty may be obviated by wrapping a few layers of kraft paper around the delay device. It is understood that delay-action electric detonators may now be obtained in which the gases of the spit are cooled

of greater absorbing power and longer life, but consideration of the problem shows that there are certain definite limits to the amount of oxygen that a given cartridge can absorb, and these limits have been approached very closely by cartridges packed with finely divided carbon in the form of ordinary lampblack or gas-black.

It is obvious that the maximum amount of oxygen that a cartridge can absorb will be a volume of liquid equal to the volume of the cartridge. No actual cartridge can absorb this ideal amount, because the particles of the combustible occupy a part of the space in the cartridge. It has been shown experimentally that a cartridge of lampblack, density 0.30 g. per c.c., absorbs a volume of liquid oxygen equal to 85 per cent the volume of the cartridge.

Packing Density an Important Factor

As the weight of oxygen that can be put into a cartridge is limited, it is evident that the weight of combustible which this oxygen will completely burn is also limited. The weight of combustible in a unit volume of cartridge, or the packing density, becomes therefore the most important factor in determining the available life of a cartridge of given size. The lighter the packing density the longer will be the available life and the lower the explosive effect. Lack of recognition of this very simple relationship has confused many experimenters in their search for suitable combustible materials.

The factors determining the available life of an L.O.X. cartridge are: (1) the amount of oxygen initially absorbed; (2) the amount of oxygen required for complete combustion; and (3) the rate of evaporation of oxygen from the cartridge. The first factor depends upon the volume of the cartridge occupied by the combustible particles into which oxygen cannot penetrate (or, in other words, is a function of the apparent or over-all density of the cartridge) and on the true density of the particles. The second factor depends on the apparent density of the cartridge and its oxygen factor, or the amount of oxygen required to burn a unit weight completely. The third factor depends on the diameter of the cartridge, the character of the combustible material and the environment (temperature of surroundings, and whether evaporation takes place in still or moving air, at reduced or elevated pressure, or the cartridge is confined to a borehole).

In underground blasting, cartridges 1½ in. in diameter and smaller are employed. The life of these cartridges varies from zero to fifteen minutes, depending upon the packing density and nature of absorbent. The larger cartridges used in quarrying may have a life of sixty minutes or longer, depending upon the size of the cartridge.

In the discussion in this article, L.O.X. cartridges will be considered as cartridges packed with lampblack or gas-black, unless otherwise stated.

Explosive Strength of L.O.X. Variable

The explosive strength of an L.O.X. cartridge is a variable quantity which depends upon the composition of the cartridge material, density of packing, size of cartridge, and time of evaporation after cartridges are removed from the liquid and before firing. Cartridges begin to lose strength almost from the instant they are removed from the liquid. There is no "ideal" moment at which they have maximum strength other than the moment they are removed from the dipping container.

It has been shown by tests with the ballistic pendulum that 1½-in. cartridges, packed with gas-black, fired five minutes after removal from the dipping container, may have a strength 10 per cent greater than 40 per cent gelatin dynamite volume for volume, but no cartridge material has been found which will develop a greater relative strength than this. The strength

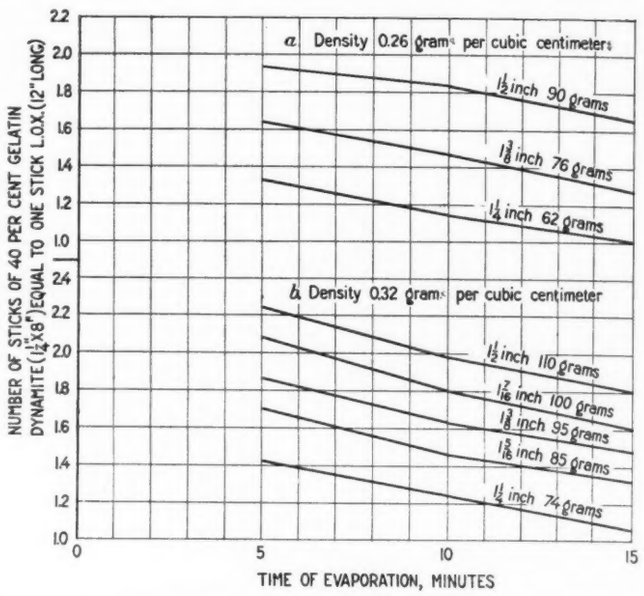


Fig. 1—Explosive strength of lampblack cartridges as related to size and density

mentioned is developed by cartridges of gas-black of density 0.38 g. per cubic centimeter, having a theoretical available life of one or two minutes. If fired after ten minutes' evaporation the strength is about 95 per cent that of dynamite. On the other hand, if longer life is desired, a cartridge packed to a density of 0.24 g. per cubic centimeter will have a life of about ten minutes, but an explosive strength less than the more dense cartridge. After five minutes' evaporation the strength of such a cartridge will be about 99 per cent that of 40 per cent gelatin dynamite, and after ten minutes' evaporation about 80 per cent the strength of dynamite.

Explosive Strength Calculated From Evaporation Test Data

On the assumption that a given amount of carbon combining with a definite amount of oxygen produces a definite explosive strength, it is possible by making use of data obtained with the ballistic pendulum to calculate the explosive strength at any given time from the data of a simple evaporation test. Though the assumption above set forth is not strictly justified in comparing cartridges of widely different packing densities, it gives results of value in calculating the approximate dynamite equivalent of different L.O.X. cartridges.

Table I shows the relation between explosive strength and oxygen content and the method of calculating explosive strength in terms of 40 per cent gelatin dynamite for any cartridge on which an evaporation test has been run. In Fig. 1 the explosive strengths of a number of gas-black cartridges of different sizes on which evaporation tests were made at Cerro de Pasco have been plotted in terms of sticks (1¼x8 in.) of 40 per cent gelatin dynamite. These curves show graphically the advantage of using cartridges of as large a diameter

Table II—Data from L.O.X. Blasting at Whitecap Mine, Leadville, Colo.

Round No.	Cartridges: Type	No.	Weight, Grams	Density, Grams per Cubic Centimeter	Life, Minutes	No. of Holes	Average Depth of Hole, Inches	Loading Time: Min.	Loading Time: Sec.	Firing Time, Min.	Analysis of Air Before Blast, Per Cent: CO_2	O_2	N_2	Analysis of Air After Blast, Per Cent: CO_2	O_2	CO	H_2	CH_4	N_2	Volume of Drift, Cu.Ft.	Ratio $\frac{CO}{CO+CO_2}\times 100$	Cubic Centimeter CO (0 Deg. C. and 760 mm. Hg) Produced per Cubic Centimeter of Explosive
4	Lampblack	18	68.5	0.21	14	9	44	3	15	8	0.17	21.38	78.45	1.56	22.46	0.09	0.00	0.00	75.89	4,260	6	12.5
1	Lampblack	21	78	0.24	12	8	48	3	45	10	0.21	22.00	77.79	2.07	23.20	0.32	0.00	0.00	74.41	4,040	15	36
2	Lampblack	17	78	0.24	12	8	44	4	30	12	0.12	21.22	78.66	1.66	22.21	0.46	0.00	0.00	75.67	4,110	23	65
3	Gas-black	18	97.5	0.30	4	8	46	3	15	10	0.18	21.47	78.35	1.65	22.28	1.08	0.04	0.00	74.95	4,185	42	147
7	Gas-black 60, peat 40	19	113	0.35	3	9	43	2	50	10	0.31	21.40	78.29	1.70	22.03	1.41	0.30	0.00	74.56	4,486	50	195
5	Gas-black 50, aluminum 50	17	133	0.41	5	8	45	2	40	10	0.19	21.27	78.54	1.49	21.76	0.68	0.00	0.00	76.07	4,345	34	102
6	40 per cent gelatin dynamite	19	165	1.6	..	6	19	..	..	..	0.24	21.20	78.56	0.85	20.81	0.11	0.00	0.00	78.20	4,415	15	46

Table III—Gases Produced by Detonation of Cartridges, Clorinda Tunnel, Cerro de Pasco, Peru

Type	Cartridges: Diameter, Inches	Weight, Grams	Density, Grams per Cubic Centimeter	No.	Life, Minutes	No. of Holes	Average Depth, Inches	Volume of Tunnel + Crosscuts, Cu.Ft.	Loading Time, Min.	Firing Time, Min.	Method of Firing	Analysis of Air Before Blast, per Cent: CO_2	O_2	N_2	Analysis of Air After Blast, per Cent: CO_2	O_2	CO	H_2	N_2	Ratio $\frac{CO}{CO+CO_2}\times 100$	CO Produced per Stick, Cu.Ft.	Cubic Centimeter of CO per Cubic Centimeter of Explosive	Cubic Centimeter of CO per Cubic Centimeter of Explosive Reduced to 0 Deg. C. and 760 Mm. Hg.
D-1	1¼	70	0.29	25	2.5	9	40	6,940	5	10	E(*a*)	0.07	20.90	79.03	1.05	21.60	0.75	0.25	76.35	43	2.10	246	135
D-1	1½	100	0.29	17	5	9	43	6,490	6	12.5	F(*b*)	0.05	20.70	79.25	1.08	21.55	0.72	0.30	76.35	41	2.74	222	122
Gas-black	1¼	80	0.27	16	7	9	40	6,670	5½	12	F	0.16	21.00	78.84	1.60	21.80	0.60	0.15	75.85	29	2.50	242	133
Gas-black	1¼	80	0.27	18	7	9	38	6,860	5½	10	E	0.07	20.94	78.99	1.55	22.40	0.41	0.12	75.52	22	1.56	151	83
Gas-black	1¾	90	0.31	17	5	9	44	7,060	6	8	E	0.00	21.95	78.05	1.36	22.50	0.30	0.04	75.80	18	1.25	121	66
Acetylene black	1¾	70	0.24	20	12	11	40	7,165	3½	8	E	0.07	20.90	79.03	1.47	22.51	0.07	0.01	76.15	5	0.25	24	13
Gas-black	1½	110	0.32	17	5	9	38	6,570	5½	12.5	F	0.17	20.85	78.98	1.45	21.90	0.36	0.10	76.19	22	1.39	113	62
Gas-black	1½	90	0.26	21	9	10	35	6,090	5	10	F	0.10	20.98	78.92	1.69	22.51	0.32	0.08	75.40	17	0.93	76	42
35 per cent gelatin dynamite	1½	250	1.55	34	..	10	40	6,200	..	..	F	0.05	20.95	79.00	1.25	22.50	0 16	0.08	78.01	12	0.29	51	28

(*a*) Electric. (*b*) Fuse.

Table IV—Gases Produced by Blasting in Diamante and Excelsior Mines, Cerro de Pasco, Peru

Round No.	Place	Cartridges: Type	Density, Grams per Cubic Centimeter	Diameter, Inch	Weight, Grams	Number	Life, Min.	No. of Holes	Average Depth, Inch	Loading Time, Min.	Firing Time, Min.	Place Sample Taken	Analysis of Air After Blast, Per Cent: CO_2	O_2	CO	H_2	N	Ratio $\frac{CO}{CO+CO_2}\times 100$	SO_2	H_2S
									A. Diamante, Rumiallana Level.											
2	R-113	Gas-black	0.27	1⅜	80	10	7													
			0.28	1 7/16	90	20	8.5	10	60	6.5	8	30 ft.	1.25	20.28	0.00	0.00	78.47	0	....	.....
3	R-113	Gas-black	0.27	1⅜	80	8	7					Face	13.50	21.30	1.37	0.37	63.46	9	....	.....
			0.28	1 7/16	90	16	8.5	8	60	6.5	8	30 ft.	1.40	21.03	0.04	0.01	77.52	3	....	.....
4	R-113	Gas-black	0.27	1⅜	80	8	7					Face	24.96	18.89	1.10	0.27	45.22	4	....	.....
			0.28	1 7/16	90	16	8.5	8	63	4	6	30 ft.	1.55	21.74	0.00	0.00	76.71	0	....	.....
6	R-113	Gas-black	0.31	1⅜	90	23	4	8	65	3.5	5	Face	0.96	21.23	0.07	0.06	77.77	7	....	.....
8	R-113	Carbene cork	0.32	1½	95	6	4	3	60	4.5	6	20 ft.	0.91	21.00	0.02	0.07	78.05	2	....	.....
9	R-114-S	Carbene cork	0.33	1 7/16	105	42	2	14	60	8.0	10	Face	3.62	28.50	0.17	0.04	67.67	4	....	.....
10	R-114-S	Gas-black	0.27	1⅜	80	15	7					30 ft.	1.32	20.51	0.95	0.25	76.97	42	0.15	0.025
			0.28	1 7/16	90	27	8.5	14	55	6.5	7.7	30 ft.	1.50	20.58	0.17	0.06	77.69	10	0.94	.....
11	R-114-N	Gas-black	0.28	1 7/16	90	39	8.5	13	60	6.3	7.8	30 ft.	0.98	20.55	0.15	0.03	78.29	13	0.32	0.019
12	R-116	35 per cent gelatin dynamite	1.55	1¼	250	55	...	14	60	....	....	15 ft.	2.01	19.39	0.26	0.20	78.14	11	0.00	0.00
									B. Excelsior, 1,400 Level											
1a	1,401 drift	Gas-black	0.28	1 7/16	90	4	8.5													
			0.32	1½	110	12	5	4	84	9	11.5	80 ft.	0.89	20.83	0.34	0.10	77.84	28	....	.....
1b	1,401 drift	Gas-black	0.28	1 7/16	90	4	8.5													
			0.32	1½	110	4	5	4	44	5.5	7.5	80 ft.	1.80	21.25	0.54	0.16	76.25	23	....	.....
2a	1,401 drift	Gas-black	0.28	1 7/16	90	8	8.5													
			0.32	1½	110	10	5	4	84	3.5	5.3	80 ft.	1.32	20.67	0.05	0.01	77.95	4	0.15	.....
2b	1,401 drift	Gas-black	0.28	1 7/16	90	28	8.5													
			0.32	1½	110	18	5	14	72	9	10.8	80 ft.	1.62	21.17	0.48	0.10	76.73	23	0.14	0.010

before being liberated and which are suitable for use with L.O.X.

In firing L.O.X. with electricity, detonators are placed in the bottom of the boreholes, and the round, except the connecting up to the firing line, is wired up before loading is begun. In loading, the first cartridge may be slipped past the delay and made to bottom in the hole. Because of the method of loading with L.O.X., delays should not be too bulky, or too great a portion of the bottom of the hole will be occupied by the delay and a very small cartridge must be employed to bottom in the hole. The type of delay which is protected by a soft rubber covering is not suitable for use with L.O.X.

Field Tests Recently Made with L.O.X. at Leadville, Colorado

As previously explained, it is possible to determine from a simple evaporation test the available life of any L.O.X. cartridge, and, theoretically, if the cartridge is detonated within this time no CO should be produced. There remains the possibility, however, that equilibrium conditions are not reached in actual blasting. As oxygen evaporates from cartridges in a borehole, the paper wrapper and outer layers of lampblack lose practically all of their oxygen, while the inner part of the cartridge retains an excess of oxygen. Thus, while at a given time of firing the total oxygen content of the cartridge may be sufficient to burn all of the cartridge to CO_2, this oxygen is not evenly distributed over the whole cartridge and some CO may be first formed and cooled below the combustion point without combining with the excess oxygen in the inner part of the cartridge.

In November, 1924, by arrangement with L. E. Bedortha, of the Purox Company, Denver, Colo., a series of tests was made in the Whitecap mine, Yak Tunnel, Leadville, Colo. The technique of blasting with L.O.X. had already been worked out by the Purox Company, and it was the purpose of these tests to determine the quantity of CO produced by lampblack cartridges of different densities together with several other cartridge compositions. The blasting was carried out in the A-2 drift in a dike of Birdseye porphyry. Dimensions of the drift were 5½x7½ ft. A typical round is shown in Fig. 2. In the experimental work one-half of the round was broken at a time, so as to increase the number of tests, which might be made for a given amount of drilling and mucking.

Sampling After-Gases

To confine the gaseous products of the blast in a definite volume, a brattice frame was constructed about 100 ft. from the face and a brattice cloth so arranged that it could be let down immediately after the blast. Then observers wearing oxygen breathing apparatus entered the drift and took gas samples from the brattice to the face at distances of 20 ft. The samples were taken in citrate bottles, which contained a small amount of mercury, by displacement of the air in the bottle by means of a rubber aspirator bulb and tube. Bottles were stored neck down and in this way were sealed by the mercury, which prevented leakage or solution of the gases in the rubber gasket. Samples were analyzed in a Haldane apparatus and results averaged to give the figure set down in Table II.

In Table II, the figure representing the amount of CO produced has been calculated to the unit: cubic centimeter of CO (at 0 deg. C. and 760 mm. mercury) per cubic centimeter of explosive. This gives a comparative figure for the total CO produced by blasts, provided that equal volumes of the explosives are employed; if a greater volume of one explosive must be used than of another, a further correction is obviously necessary. The barometric pressure in the mine was about 515 mm. of mercury, and the temperature was 8 deg. C. In the column headed "Firing Time" is given the time in minutes which elapsed from the beginning of loading to the last report of the round—in other words, the maximum time of evaporation. Those cartridges which were loaded last evaporated in 2½ to 4½ minutes less than this, depending upon the time taken to load the round. All of the L.O.X. cartridges were 1½x11 in. in size. The 40 per cent gelatin dynamite was in 1 by 8-in. cartridges.

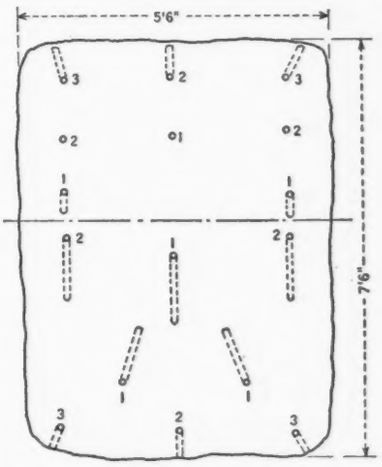


Fig. 2—Typical round in A-2 drift, Whitecap mine, Leadville, Colo., broken in two shootings for experimental purposes

It will be noted that L.O.X. cartridges of density of 0.24 g. per cubic centimeter with a theoretical life of twelve minutes, when fired after a maximum of ten minutes' evaporation, produced 36 c.c. of CO per cubic centimeter of explosive, against 46 c.c. for the 40-per cent gelatin dynamite. A cartridge of a density of 0.21 g. per cubic centimeter, with a theoretical life of fourteen minutes, fired after eight minutes' evaporation, produced 12.5 c.c. CO per cubic centimeter of cartridge. When cartridges of higher density were employed, namely, 0.30 g. per cubic centimeter, 147 c.c. of CO was produced, or about three times that produced by the dynamite. A mixture of gas-black and peat produced 195 c.c. of CO and one of gas-black and aluminum produced 102 c.c.

When comparing lampblack cartridges the ratio $\frac{CO}{CO + CO_2}$ is an indication of the amount of CO produced, if the weight and number of cartridges used is known. This ratio indicates the percentage of the total carbon gasified which was oxidized to carbon monoxide. The total quantity of CO so calculated is usually larger than the amount calculated from the volume of the drift and percentage CO, due to leakage of some of the gas past the brattice, but the relative values agree fairly well. In determining this ratio, the percentage of CO_2 present after the blast has been corrected for that present before the blast.

It is evident from the data in Table II that cartridges must be fired with a considerable excess of oxygen to produce amounts of CO equal to or less than that produced by the sample of gelatin dynamite used. Where the amount of CO produced is an important factor, no greater density than 0.24 g. per cubic centimeter should be employed. Such a cartridge will have a ballistic strength 90 per cent that of 40 per cent gelatin dyna-

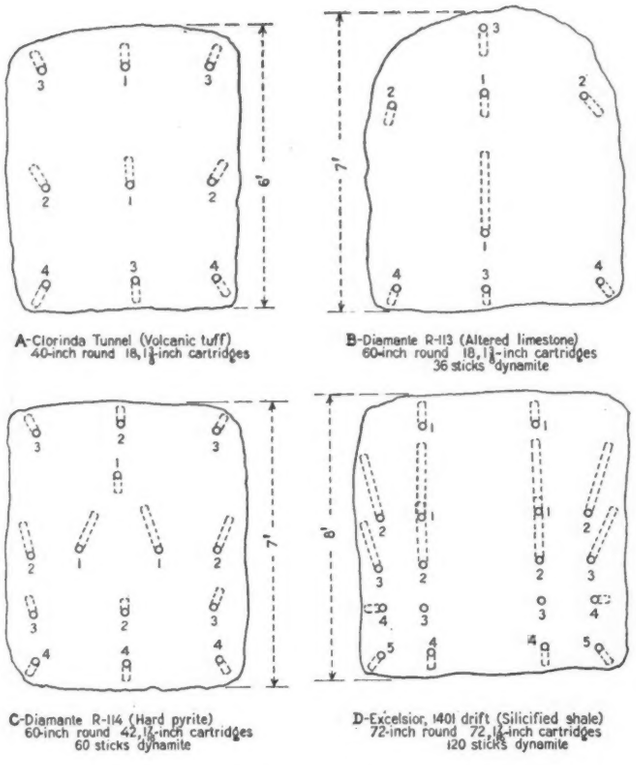

A-Clorinda Tunnel (Volcanic tuff)
40-inch round 18, 1⅛-inch cartridges
B-Diamante R-113 (Altered limestone)
60-inch round 18, 1⅛-inch cartridges
36 sticks dynamite
C-Diamante R-114 (Hard pyrite)
60-inch round 42, 1⅛-inch cartridges
60 sticks dynamite
D-Excelsior, 1401 drift (Silicified shale)
72-inch round 72, 1⅛-inch cartridges
120 sticks dynamite

Fig. 3—Typical rounds at Cerro de Pasco

mite, if fired after five minutes' evaporation, and 80 per cent after ten minutes' evaporation. Where greater explosive strength is desirable and sufficient ventilation is available to dilute the CO, a cartridge packed to a density of 0.30 g. per cubic centimeter may be used. Such a cartridge will produce 110 per cent the strength of dynamite, if fired after five minutes' evaporation, and 88 per cent after ten minutes.

At Cerro de Pasco, Peru

At the request of C. V. Drew, vice-president of the Cerro de Pasco Copper Corporation, I carried out experimental blasting tests during February, March, and April, 1925, at the mines of the company at Cerro de Pasco, Peru. A Messer machine with rated capacity of 25 liters of liquid oxygen per hour had been installed and was in operation when I arrived at the mine.

Evaporation tests of lampblack cartridges indicated that the evaporation rate at Cerro de Pasco, altitude 14,300 ft., was somewhat less than at sea level. Previous tests at Pittsburgh in a Bichel gage had also shown that evaporation was slower at reduced pressures, provided the cartridge is suspended in the atmosphere or in a loose-fitting borehole, but when placed in a tight-fitting borehole the evaporation is the same whatever the pressure. This is reasonable enough, because the rate of evaporation is determined by the rate at which heat is conducted to the cartridge. If the cartridge is so situated that most of its heat must be obtained from the gases surrounding it, then the lower the pressure the lower will be the heat content of a unit volume of gas and the less heat will be conducted to the cartridge. If, on the other hand, the cartridge is receiving its heat entirely from the walls of a close-fitting borehole, the atmospheric pressure should make practically no difference.

First blasting was done in Clorinda tunnel, a small surface tunnel in fairly soft volcanic tuff. The purpose of this work was primarily to determine composition of the gaseous products of detonation. A typical round is shown in Fig. 3-*A*. A brattice was constructed about 100 ft. from the face, and tests were carried out in a manner similar to those at Leadville. The SO_2 and H_2S were not determined in the citrate bottle sample secured for analysis with the Haldane apparatus, but by a separate determination.[4] An average barometric pressure of 440 mm. of mercury and a temperature of 15 deg. C. prevailed during the tests. Fuse and caps were used in most of the work in Clorinda tunnel, but electric delay-action detonators were obtained later and used in four of the tests. Results are given in Table III.

Discussion of Results in Table III

From Table III it will be seen that 1½-in. cartridges of gas-black, density 0.27, when detonated in ten minutes, produced 42 c.c. of CO per cubic centimeter of cartridge compared with 83 c.c. for a 1⅛-in. cartridge under similar conditions; 1⅛-in. cartridges of acetylene black, density 0.24 g. per cubic centimeter, fired in eight minutes produced only 13 c.c. of CO per cubic centimeter of explosive; 35 per cent gelatin dynamite produced 28 c.c. of CO.

The carbene-cork mixture (70 per cent carbene, 25 per cent cork, 5 per cent aluminum) a German cartridge, 1½-in. diameter, density 0.29, fired in 12.5 minutes produced 122 c.c. of CO, and a 1½-in. cartridge of gas-black fired after 12.5 minutes produced 62 c.c.

Results show the increase of CO produced as the diameter of the cartridge is decreased and as the density in increased, and the carbene mixture produces at least twice the CO that a similar gas-black cartridge produces. It is evident that cartridges may be fired within or near the life period and still produce some CO, but the quantity produced increases rapidly as the time of firing is increased beyond the life period.

With the time of firing well within the life period, for example, in the round with acetylene black cartridges, the amount of CO produced is considerably less than that produced by dynamite.

Further work in the Clorinda tunnel would have been interesting, but it was believed that tests in actual blasting in the mines would be more profitable and further gas samples could be obtained there. Electric firing was employed in all experimental work in the mines, but was not used in the regular routine blasting carried on by the company. A brief discussion of the work in the mines follows:

Diamante Mine, Crosscut R-113

The ground in the Diamante mine is altered limestone and is easily broken. A typical eight-hole jackhammer round is shown in Fig. 3-*B*. In the first round shot, one 1⅛-in. and two 1⅞-in. cartridges were used per hole. A perfect break was obtained and apparently no gas, a fact confirmed by the gas analysis, which showed no detectable amount of CO. This round was blasted fre-

[4]Determination of SO_2 and H_2S was made as follows: (1) $SO_2 + H_2S$. A definite volume of air was aspirated through two bubbling absorption bottles containing N/20 iodine solution and a catch bottle containing N/20 $Na_2S_2O_3$ solution. The excess iodine was then titrated with N/20 $Na_2S_2O_3$. A blank was run on the method by pumping the same volume of pure air through similar solutions and titrating with thiosulphate. (2) H_2S. Four bottles containing ammoniacal $CdCl_2$ were used. After the required amount of air had been bubbled through the solution, the precipitated CdS was filtered off, washed, dissolved in a large volume of water acidified with H_2SO_4, and titrated with N/20 $KMnO_4$ solution. Results of (1) were corrected for the H_2S found in (2).

quently thereafter and the quantity of cartridges reduced until only eighteen 1⅛-in. cartridges were used. It was found possible to load and fire the round in as little time as five minutes. The quantity of CO in the drift a few feet from the face was negligible when gas-black cartridges were used. In this round the waste is usually thrown back from the face and leaves a pocket near the face, where a very concentrated gas sample may be obtained. For example: Round 4, Table IV, the face sample contained 24.96 per cent CO_2 and 1.10 per cent CO, indicating that only 4 per cent of the carbon was oxidized to CO, the remainder forming CO_2.

Diamante Mine Crosscut R-114, North and South

This drift is in hard pyrite and a 14-hole round usually takes sixty sticks of dynamite. (See Fig. 3-*C*.) It was found possible to break bottom with forty-two sticks of 1⅞-in. L.O.X. With two men loading and one passing, the round may be fired eight minutes after the first cartridge is removed from the container.

The amount of CO formed when using gas-black cartridges is not high—about 0.15 per cent—but considerable SO_2 and a little H_2S are formed. In one round a concentration of 0.94 per cent SO_2 was present in the drift. In the tests at Cerro de Pasco, gelatin[5] dynamite apparently formed no SO_2 or H_2S, but more CO than the L.O.X. cartridges used. (See Round 12, Table IV, where a gelatin dynamite round produced 0.26 per cent of CO in the drift.) The SO_2 is evidently formed by combination of the fine pyrite dust with part of the oxygen of the cartridge and with the excess oxygen in the air which has evaporated from the cartridges before firing. It seems doubtful whether this condition can be prevented when L.O.X. is fired in pyrite.

The formation of SO_2 is an objection to the use of L.O.X. in pyritic ground, but need not be sufficiently serious to prevent its use if a half-hour or more can be allowed for ventilation of the drift before men return to the face. Men cannot return until the gas is sufficiently diluted to be harmless, as the gas is irritating in very low concentrations. It would prove dangerous, however, if men were in some way trapped in the gas and unable to get to fresh air.

Excelsior 1,401 Drift

Excelsior 1,401 drift is in hard silicified shale which contains small quantities of pyrite. In a 6-ft. round it is customary to use 120 sticks of dynamite. The cuts are shot twice with 62 per cent gelatin dynamite and then the fourteen holes remaining are loaded and fired with 35 per cent dynamite. A sketch of the round is shown in Fig. 3-*D*. With 1⅞-in. L.O.X. cartridges, the round has been broken to bottom in two shootings. It has been possible to load and shoot the four cuts in about 5.5 minutes (shooting was done from the 1,200-ft. level), and load and fire the remaining fourteen holes in eleven minutes.

After shooting the cuts, if done in five or six minutes, the CO should be negligible (see Round 2a, Table IV) but after shooting the remaining holes the CO is about 0.5 per cent. In all rounds air was blown for half an hour at the face after taking gas samples, before observers returned to the face. Here again sufficient SO_2 was produced to make it impossible to return to the face before all the gases have been diluted to harmless proportions. The SO_2 immediately after the blasts was about 0.15 per cent, sufficient to necessitate the wearing of goggles as well as respirators while taking gas samples.

Results of tests in the Diamante and Excelsior mines are given in Table IV.

[5]Work in Arizona mines has shown production of irritating quantities of SO_2 and H_2S by dynamite.

At Pachuca, Mexico

Through the courtesy of the United States Smelting, Refining & Mining Co. and the Cia. de Real del Monte y Pachuca, Pachuca, Hidalgo, Mexico, I observed operations and carried on experimental work at Pachuca during August and September, 1924.

Use of L.O.X. was begun at Pachuca in August, 1921, and has been completely described by Kuryla and Clevenger,[6] engineers with the United States company. The interested reader is referred to this paper for details of the plant and method of using L.O.X. at Pachuca. The following summary of results prepared by H. J. Filsinger, assistant superintendent of mines, indicates the quantity of L.O.X. used and results obtained at two of the mines:

Summary of Blasting Results, August, 1924

	Santa Ana	Camelia y Paraiso
Oxygen used, kg	5,592	11,010
Cartridges used	7,328	20,725
Oxygen per cartridge, kg	0.763	0.531
Holes blasted	2,583	3,916
Ore produced, tons	8,383	9,790
Ore produced per hole, tons	3.24	2.5
Cartridges per hole	2.6	2.9
Dynamite replaced, kg	1,238	3,881

Hand-packed cartridges of lampblack made by natives from Mexican fuel oil (or chapopote) are employed. Stope cartridges are 30 by 300 mm. and drift cartridges are 37 by 300 mm. As described by Kuryla and Clevenger, the cartridges were 28 mm. and 35 mm. in diameter and weighed 44 g. and 63 g., respectively. Since that time the tendency has been to pack cartridges of greater density; the stope cartridges weigh from 60 to 80 g. and the drift cartridges from 80 to 110 g. A 65-g. stope cartridge will have an available life, as shown by evaporation test, of two minutes and a 100-g. drift cartridge an available life of three minutes.

Drift holes are started 2 in. in diameter and are 1½ in. at the bottom if there has been no loss of gage. Drift rounds contain from twelve to twenty-seven holes,

[6]Kuryla, Michael H., and Clevenger, Galen H., "Liquid Oxygen Explosives at Pachuca." *Trans. A.I.M.E.*, Vol. 69, 1923, pp. 271-321. Discussion, pp. 321-340.

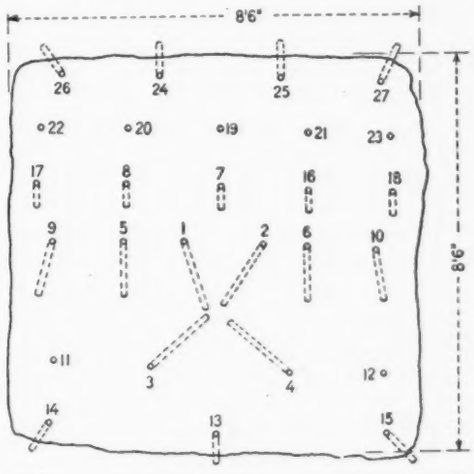


Fig. 4—A 27-hole, 60-in. round in Camelia mine, Pachuca, broken with L.O.X. cartridges

Table V—Composition of Mine Air After L.O.X. Blasts at Pachuca, Mexico

Place	Cartridges: Type	Diameter, Mm.	Weight, Grams	No.	No. of Holes	Maximum Time of Evaporation, Minutes	Distance from Face Where Sample Taken, Feet	Analysis of Air After Blast, per Cent: CO_2	O_2	CO	H_2	N_2	Ratio, $\frac{CO}{CO+CO_2} \times 100$
Drift Veta 4, 290 level	Native lampblack	37	90	30	5	10	10	0.51	20.94	0.38	0.10	78.07	43
345 E. drift	Native lampblack	37	90	19	5	8	20	0.56	20.65	0.34	0.08	78.37	38
345 E. drift	Native lampblack	37	90	31	7	11.5	60	0.58	20.92	0.40	0.08	78.02	41
405 E. drift	Gas-black	37	80	20	7	5	40	0.84	20.80	0.12	0.09	78.15	13
405 E. drift	Gas-black	37	80	31	9	9	40	0.69	20.69	0.39	0.10	78.13	36
San Juan tunnel, untamped holes	Native lampblack	30	75	12	12	12	5	0.46	20.99	0.15	0.00	78.40	25
	Native lampblack	30	75	9	26	14	5	0.68	20.53	0.03	0.00	78.74	40

depending upon the nature of the rock and ore. The type of round usually employed is the pyramid cut which consists of three or four holes drilled so that they meet or nearly meet at a common point. Holes vary in depth from 4 to 6 ft. and from three to five cartridges are used per hole. In both dynamite and L.O.X. practice it is customary to pull the cut holes first and then load and break the remainder of the round. With dynamite, two to three shootings are sufficient to break the round, but with L.O.X. from three to four are required. Maximum time of evaporation—that is, the time-interval which elapses between removal of the first cartridge from the dipping container and the last report of the round—varies from eight to thirteen minutes.

Stope holes are started 1½ in. in diameter and finish at 1⅛ in. Depth varies from 3 to 5 ft. From twenty to thirty holes are fired in one shooting and the maximum time of evaporation is from eleven to fifteen minutes. About three sticks of L.O.X. are used per hole.

A typical twenty-seven-hole drift round is shown in Fig. 4. This was broken with L.O.X. in four shootings; the holes were fired in the order shown.

The country rock is andesite-porphyry, and according to W. M. Davey, chief geologist[7] for the Real del Monte company, it would not be characterized as extremely tough ground, but would compare with a normal fresh granite such as might be found in the Lake Superior country or at Butte.

A series of comparative tests by one of the company engineers during June and July, 1924, showed L.O.X. to be somewhat inferior in breaking strength to 40 per cent gelatin dynamite, either on the basis of amount of rock broken per inch of hole drilled or per stick of explosive. It is believed, however, that substitution of electric firing for fuse and caps would have improved results materially. The use of gas-black instead of the locally made product was also shown to result in increased explosive strength.

In Table V are given gas analyses obtained after L.O.X. blasts. As it was not feasible to change the regular routine of blasting practice during the taking of the samples, which consists in turning on compressed air at the face after fuses have been spit, samples were taken in the smoke at some distance from the face and the products of detonation were naturally much diluted. However, the high ratio of CO to $CO + CO_2$ in most of the samples shows that considerable quantities of CO were produced, and the actual concentration in the drift was 0.35 to 0.40 per cent CO, or sufficient to cause a bad headache in a short time. One round, in which gas-black cartridges were fired after five minutes' evaporation, showed only 0.12 per cent CO, or a value of 13 per cent for the ratio $\frac{CO}{CO + CO_2}$. An interesting feature is the low CO content of the samples taken after detonation of untamped holes. The cartridges at the time of firing did not contain sufficient oxygen for combustion to carbon monoxide, yet a high ratio of carbon dioxide to carbon monoxide was obtained. Evidently considerable after-burning takes place with untamped holes.

[7]Kuryla, M. H., and Clevenger, G. H., work cited. Discussion p. 325.

Comparative Cost of L.O.X. and Dynamite

Although insufficient operating data are available to give cost figures of general applicability, figures from the Pachuca operation and from German data are of interest. Kuryla and Clevenger,[8] from the operation of a 25-liter plant at Pachuca, Mexico, estimate a cost of 9.35c. for the L.O.X. required to replace a pound of dynamite. From data obtained with this plant they estimated for a 100-liter plant a cost of 6.25c. to replace a pound of dynamite. Diedrichs[9] for a coal-mining operation employing a 20-liter plant estimates a cost of 9.3c. per pound of gelatin dynamite produced. This figure is identical with that of Kuryla and Clevenger, but includes interest and amortization, whereas those of Kuryla and Clevenger do not.

In making calculations of the amount of liquid oxygen required for L.O.X. cartridges, it is best to figure on the basis of unit volume of cartridge rather than unit weight, because the amount of oxygen used per unit weight of cartridge obviously decreases as the density of packing increases. In the present state of knowledge an assumption as accurate as any is that for every 1 c.c. of L.O.X. cartridge 2 g. of liquid oxygen must be produced at the plant. In these units the amount of liquid will vary but little with the density of the cartridge.

From Fig. 1, a lampblack cartridge of density 0.26 g. per cubic centimeter, 1½x12 in. in size, fired after ten minutes' evaporation, will have a strength equal to 1.84 sticks of 40 per cent gelatin dynamite, weighing 250 g. each, or about 1 lb. of dynamite. As the volume of the L.O.X. stick is about 350 c.c., 0.7 kg. of liquid must be produced at the plant per stick of L.O.X. on the assumption that 2 g. of liquid are required per 1 c.c. of cartridge. With lampblack at 10c. such a cartridge can be made for about 3c. With oxygen at 9c. per kilogram, we have a cost of 9.3c. for L.O.X. to replace 1 lb. of dynamite. If oxygen could be produced for 5c. per kilogram, as is reported for a 75-liter plant using the Claude process, the cost to replace 1 lb. of dynamite would be 7.5c.

From such data as are available it does not seem safe to assume a cost per pound of dynamite replaced by L.O.X. of less than 10c. for a small operation. The feasibility of using L.O.X. from the economic point of view will depend upon the price of dynamite, and will at present make the use of the explosive more

[8]Kuryla, M. H., and Clevenger, G. H., work cited.
[9]Diedrichs, H.: "Die Erzegung und Verwendung Flüssigen Luft zu Sprengwecken." *Stahl und Eisen*, Vol. 35, 1915, p. 1180.

attractive to properties operating in the Latin-American countries than has so far been considered practicable in the United States.

Open-Cut Blasting Seems a Favorable Field for L.O.X.

It is not within the province of this paper to discuss open-cut blasting, other than to state that such operations appear to offer a favorable field for L.O.X. when blasting is carried on regularly and the capacity production of the plant can be used. Here the production of carbon monoxide is of practically no importance; large cartridges of high explosive strength and long explosive life may be used, and the distribution and soaking losses are considerably less. Successful operations in the limestone quarries of Sorcy, France, have been reported[19] and a large number of successful blasts have been reported in this country in quarries near Lebanon, Pa., by the Air Reduction and Ingersoll-Rand companies.

Conclusions

1. There is reason to believe that L.O.X. may have a field in underground work for (*a*) operations not in tough ground and where cartridges of less strength than 40 per cent gelatin dynamite may be used (such L.O.X. cartridges produce less CO than the L.O.X. cartridges of greater strength); (*b*) workings so well ventilated as to make the matter of CO production relatively unimportant; and (*c*) operations requiring cartridges of maximum strength, but in which a small number of holes are loaded at a time, and the round may be fired after a total evaporation time of six minutes or less. Successful operations have been reported in the iron mines of Lorraine, France, where it is customary to fire only a small number of holes at one time.

2. On the other hand, in the present state of development, it is believed that L.O.X. cannot be recommended for general use in underground blasting because (*a*) L.O.X. cartridges with a strength near that of 40 per cent gelatin dynamite produce considerably more CO than the gelatin, unless fired within six or seven minutes after loading is begun (a very difficult feat in large rounds); (*b*) in ground containing pyrite a large amount of SO_2 is produced—an irritating gas not as dangerous as the odorless CO, yet which affords a certain inconvenience and hazard; (*c*) L.O.X. cartridges are highly flammable and should not be used where miners employ open-flame lights; (*d*) it is not feasible to use L.O.X. in workings difficult of access or in holes running water; and (*e*) L.O.X. cannot be used to replace an explosive of greater than 40 per cent strength.

3. It is important for companies considering the trial of L.O.X. in underground work to realize that its introduction requires a knowledge of the factors governing explosive properties and CO production, training of men in the use of L.O.X., and careful attention to every detail from the making of cartridges to their final detonation in the borehole.

4. Open-cut blasting seems to offer a favorable field for the use of L.O.X. when blasting is carried on regularly and the twenty-four-hour production of the plant can be used.

[19]Unpublished report of George S. Rice, Chief Mining Engineer, U. S. Bureau of Mines.

Oregon's Metal Output Less in 1925

The value of gold, silver, copper, and lead produced in Oregon in 1925, according to the estimate of J. M. Hill, of the U. S. Bureau of Mines, was $429,088, a decrease of $248,984 compared with the value of metals produced in 1924. The greatest decreases in value were in copper, which was 81 per cent less, and gold, which was 30 per cent less than in 1924. Lead was the only metal which showed an increase when compared with the previous year. Chief interest in eastern Oregon during 1925 was centered in the development of the copper deposits east of Baker, near Keating, on Powder River.

In 1925 it is estimated that 18,630 fine oz. of gold was produced, compared with 26,695 oz. in 1924. The Cornucopia quartz mine and the Empire and Superior dredges were the largest producers of gold. The placer-gold yield was less because of decrease in the number of dredges operating.

The silver output was 34,930 fine oz., only 3,173 oz. less than in 1924. Most of the silver was from silver and copper ores produced in eastern Oregon.

Homestead-Iron Dyke, the only large producing copper mine in Oregon, was operated three months in 1925, so the copper production was reduced to 132,500 lb., compared with 768,395 lb. in 1924.

The lead yield in 1925 was 13,200 lb., an increase of 12,687 lb. compared with 1924. The bulk of the lead was contained in mixed lead-copper concentrates produced in eastern Oregon.

Beneficiation of High-Silica Iron Ores

An investigation is being conducted at the Southern experiment station of the Bureau of Mines, Tuscaloosa, Ala., to develop a means of treating low-grade high-silica iron ores of the south, and particularly of the Birmingham district, whereby they may be rendered available for blast-furnace use. With the development of satisfactory methods of treatment will come a large increase in the iron-ore reserves.

The purpose of the four studies is, (1) in the case of high-silica red ores, to remove part of the insolubles of the ore with a minimum loss of iron, thereby increasing the iron content in the product going to the blast furnace; (2) in the case of high-silica, specular gray hematite, the objective is similar to that for the high-silica red ores; (3) in the case of low-grade brown ores, to develop a coarse treatment for removal of clay, gravel, and chert; and (4) in the case of blast furnace flue dust, to remove enough carbon and insoluble material from the flue dust to make a concentrate high enough in iron for blast-furnace use.

During the last fiscal year considerable work was done on the red and gray hematite. Tests have been completed on samples of ore from a number of localities in the red-ore district of Alabama. Additional samples are being collected for further tests. Good metallurgical results have been obtained on all samples of red and gray hematites tested. Work on the brown ores was started late in the year, with good results to date. In the study of gray ores, work was completed on ores from part of the Talladega district, and begun on ores from other localities.

The results of the flue-dust investigation, which is practically completed, are irregular, owing to the many variables of the samples.

Closed-Circuit Grinding at Lake Shore Mines

Important Savings Made by Discontinuing the Open Circuit in Primary Unit of Mill

By H. W. Shoemaker
Mill Superintendent, Lake Shore Mines, Kirkland Lake, Ont.

H. W. Shoemaker

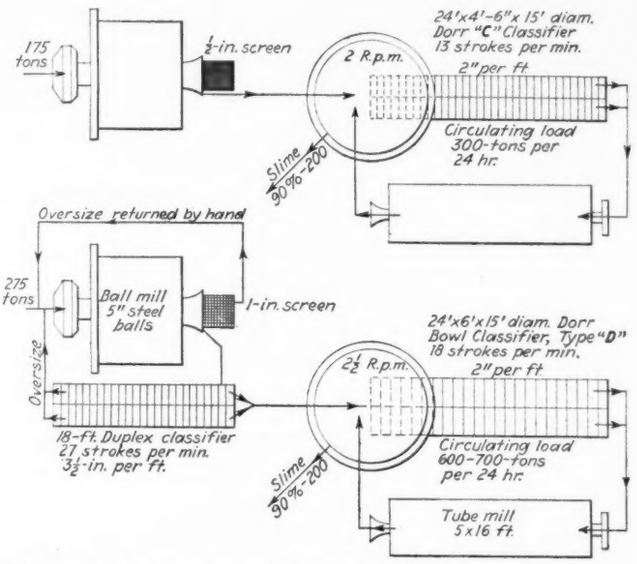
THE advantages of closed-circuit grinding and classification in each of the successive steps of wet-grinding installations have always been taken more or less for granted. Results recently attained at the Lake Shore Mines, by closed-circuiting classifiers with primary grinding units, gives striking evidence of the improvements possible by a complete application of this principle. The original unit in this mill consisted of a 7x6-ft. ball granulator delivering to a 24 ft. x 4 ft. 6 in. x 15 ft. diameter duplex Dorr bowl classifier of the lighter type known as Type "C." This classifier was in closed circuit with a 5x16-ft. tube mill using 1¼-in. steel pebbles. Feed to this unit was the product of 54x24-in. rolls delivered to the mill bins without screening at approximately minus 1 in. The finished product was approximately 90 per cent through 200 mesh at the bowl overflow. Under these conditions, and with the classifier making thirteen strokes per minute, the maximum tonnage per twenty-four hours was 175 tons. Forcing tonnage beyond this point usually resulted in mechanical troubles with the raking mechanism of the classifier. This trouble was partially remedied by speeding the rakes up to twenty strokes per minute, thus giving increased raking capacity but decreasing the load per stroke. This improvement, together with reinforcement of the head motion, enabled the unit to handle 190 to 200 tons.

Heavier Classifiers Installed

Mechanically, however, the Type "C" classifiers were too light for the job, and it was determined to replace them with the heavy duty Type "D" of the same length and bowl diameter, but 6 ft. in width. By this change it was hoped to get away from the occasional breakage of the lighter model; and by providing a heavier circulating load for the tube mill, to increase its efficiency. Their installation provided these improvements, and the duty was further increased to 225 tons per twenty-four hours.

Throughout these successive conditions, the ball granulator was running below capacity because of the necessity of favoring the classifier and tube mill. The limiting factor seemed to be the small percentage of oversize delivered by the ball mill, which accumulated in the tube and classifier circuit to a prohibitive degree. To meet this excess of capacity of the ball mill over the tube, and to make use of the discarded "C" models, the bowls were removed from these classifiers, and the raking compartments cut down to 18 ft. and put in closed circuit with the ball mill. They were steeply pitched—3½ in. to the foot—and the rakes speeded up to twenty-seven strokes per minute. The trunnion discharge of the ball mill had originally been provided with a cylindrical screen of ½-in. mesh. This was replaced with one of 1-in. mesh. Operators are instructed to load the mill until some oversize passes this screen, but the total so overfed does not exceed 500 lb. per day.

The moisture on this primary classifier is naturally kept quite low, only the coarser material being raked back and returned to the ball mill. The whole arrangement, however, is very flexible, and practically any desired sizing of product is possible. The practical effect is the elimination of that small percentage of oversize heretofore sent to the fine-grinding circuit, a finer average material for the tube mill to handle, and a better balancing of the capacities of ball and tube mill.


175 tons
½-in. screen
2 R.p.m.
24'x4'-6"x 15' diam. Dorr "C" Classifier 13 strokes per min.
2" per ft
Circulating load 300-tons per 24 hr.
Slime 90% -200
Oversize returned by hand
275 tons
Ball mill 5" steel balls
1-in. screen
24'x6'x15' diam. Dorr Bowl Classifier, Type "D" 18 strokes per min.
2½ R.p.m.
2" per ft
Oversize
18-ft. Duplex classifier 27 strokes per min. 3½-in. per ft.
Circulating load 600-700-tons per 24 hr.
Slime 90% -200
Tube mill 5x16 ft.

At top is shown the original circuit. Below is the revised arrangement with the primary ball mill in closed circuit with a classifier

Furthermore, both mills are properly loaded, it is possible to carry lower moistures, and the resultant saving in steel is considerable. In addition, the total power consumed per unit is 15 hp. less, despite the fact that the daily duty is now 275 tons compared with the 175 tons possible before the foregoing changes in operation were made.

Following are some pertinent figures of comparison. The sketches show the present and original arrangements.

	5-In. Balls,	1-In. Balls	Power — Ball Mill, Hp.	Tube, Hp	Classifier, Hp.	Cost, Cents per Ton
Original...	2.8 lb. per ton	3.1 lb.	135	165	5	36.3
Present...	1.9 lb. per ton	1.5 lb.	125	150	15	21.7
Saving....	0.9 lb. per ton	1.6 lb.	10	15	10	....
	$0.04	$0.08	...	...	..	14.6

Assuming that liner consumption is decreased half as much as the ball consumption (no data are as yet available), an additional $0.06 per ton would be added to the saving already shown. This makes a total saving on these items alone of 32.6c. per ton. The material crushed is hard red porphyry and syenite.

Spain—The World's Oldest Producer of Iron Ore

Average Annual Output for Last Twelve Years About 5,500,000 Tons Derived From Over 400 Mines—Mina Minera, Near Sagunto, Has a History of More Than Twenty Centuries

By Olin R. Kuhn
Donner Steel Co., Buffalo, N. Y.

Olin R. Kuhn

THE ART of making iron has been known for several thousand years, and the forced-draft furnace (the forerunner of the modern blast furnace) is known to have existed in the time of Rameses II, about 1,500 B. C., but today there is no sign of any of these old operations. The oldest operating iron-ore mines now known are near Sagunto, in the Province of Teruel, in Spain. The Mina Minera, near Sagunto, is probably the oldest mine in Spain, and dates back to before 219 B. C., when Hannibal took the City of Sagunto in the Second Punic War. Today these old quarries are controlled by Don Ramon de la Sota, the largest steel operator in Spain, and they have been equipped with modern electrical machinery.

Spain has always been one of the largest producers of iron ore in Europe, owing primarily to the fact that it contains some of the largest deposits of bessemer ore known, and, further, because many of these deposits occur within reasonable distance of a convenient shipping port. Although the iron-ore production of Spain varies from 3,000,000 to 10,000,000 tons annually (the average for the last twelve years was about 5,200,000 tons), about 92 per cent of the ore is exported to England, Belgium, France, Germany, the United States and other countries, as only 250,000 to 450,000 tons of pig iron is made in Spain each year. In addition to the iron ore Spain produces from 1,000,000 to 3,000,000 tons of pyrites annually, all for export.

In 1918 there were 430 iron-ore mines in operation scattered through Spain, and they produced about 4,700,000 tons of ore averaging 50 per cent in iron.

Table I—Production of Iron Ore in Spain, 1861-1923

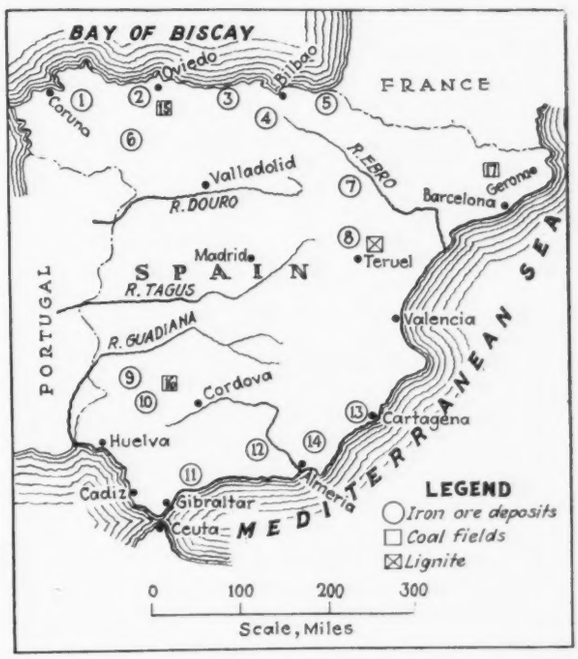
Average Yearly Production		Annual Production	
Years	Tonnage	Year	Tonnage
1861–65	198,937	1911	8,632,685
1866–70	308,580	1912	8,986,227
1871–75	602,686	1913	9,703,177
1876–80	1,670,484	1914	6,710,358
1881–85	4,052,940	1915	5,527,552
1886–90	5,109,836	1916	5,762,733
1891–95	5,287,101	1917	5,461,906
1896–1900	7,763,768	1918	4,617,332
1901–1905	8,099,149	1919	4,565,489
1906–1910	9,064,344	1920	4,693,136
		1921	2,602,400
		1922	2,771,900
		1923	3,456,200

Iron ore is found and produced in practically every province in Spain, the largest producing mines being in the provinces of Vizcaya, Almeria, Santander, Murcia, Granada, and Sevilla. At present from 400 to 450 mines are operating, which produce roughly from 5,000,000 to 5,500,000 tons of iron ore per year. The accompanying table shows the tonnage produced in 1918 and the port from which it was exported:

Table II—Iron Ore Produced by Provinces, 1918

Province	Number of Mines	Production, Tons	Iron Content	Shipping Port
Almeria	88	668,011	48.50	Almeria and Garrucha
Badojoz	1	12,572	47.00	Huelva
Cordoba	3	5,748	47.00	Malaga
Granada	8	265,080	48.17	Malaga and Almeria
Guadalajara	2	50,309	44.00	Sagunto
Guipuzcoa	5	38,454	44.00	Pasajes and Zumaya
Huelva	5	18,188	50.00	Huelva
Jean	6	12,807	50.00	Malaga
Lerida	1	764	50.00	Les (By land)
Malaga	28	52,695	55.00	Malaga and Marbella
Murcia	53	297,988	44.00	Cartagena, Aguilas and others
Navarra	7	18,174	44.00	Bilbao
Oviedo	69	68,655	44.00	Gijon, Aviles, and others
Santander	38	676,422	51.00	Santander and Castro Urdiales
Servilla	5	153,714	50.00	Sevilla
Teruel	2	45,230	46.00	Sagunto
Vizcaya	107	2,285,793	48.00	Bilbao and Povena
Zaragoza	1	21,017	47.00	
Unlisted	1	1,030	49.00	
Totals	430	4,692,651		

As stated, practically all of the iron ore produced in Spain, or over 90 per cent of it, is exported. The



Sketch map of Spain showing location of principal deposits of iron ore

Iron Ore Deposits

1. Incio, Villamea, Lugo Province
2. Proaza, Teverga, Oviedo Province
3. Cabargo, Camargo, Santander Province
4. Bilbao, Vizcaya Province
5. Guipuzcoa and Navarra Provinces
6. Wagner, Leon Province
7. Tierga, Saragossa Province
8. Sierra Menera, Teruel and Guadalajara Provinces
9. Sierra Fregenal, Badajoz Province
10. Sierra Morena, Huelva and Sevilla Province
11. Marbella, Malaga Province
12. Alquife, Almeria Province
13. Cartagena, Murcia Province
14. Bedar, Almeria Province

Coal Fields

15. Northern field
16. Southern field
17. Northeastern field

exports of ore vary from 2,500,000 to 8,500,000 tons annually, but the average over the last ten or twelve years has been close to 5,000,000 tons per year. Table III shows the distribution of the iron ore exported from Spain in 1909, 1913, 1918, and 1920.

Table III—Exports of Iron Ore from Spain

Exported to	1909	1913	1918	1920
Great Britain	4,546,005	4,741,174	4,023,243	3,839,980
Netherlands	2,430,697	2,470,344	.....	406,985
Germany	446,661	971,754	.....	.....
United States	395,396	88,384	163,834	61,517
France	162,524	383,804	88,077	123,327
Belgium	46,293	64,296	.....	49,488
Austria Hungary	17,818	37,517	.....	.....
Others	3,021	6,881	269	74,944
Totals	8,048,415	8,764,154	4,275,423	4,556,241

Minerals in Spain are the property of the state, and although anyone may obtain a concession for holding and working a property, the concessionaire must pay royalties to the state and municipality, besides several different taxes. Two royalties are levied, one a surface royalty of 6 pesetas per hectare (2.2 acres), payable whether the mine is working or idle, and the other a royalty on the ore produced, amounting to 3 per cent of the gross value of the ore at the mine. At present, this royalty amounts to between 40 and 60c. per ton of ore. In addition there is an export tax of 20c. per ton of ore shipped, and the municipalities generally charge a municipal tax, which varies from one-fourth to one-third of the royalty on ore values, or from 10 to 20c. per ton of ore. In addition to these there are various small transport, maritime, dividend, profits, and stamp taxes.

Table IV—Iron Ore and Pig-Iron Production in Spain, 1911 to 1923

Year	Iron Ore Production	Iron Ore Exports	Pig Iron Production
1911	8,632,700	7,227,000	402,100
1912	8,986,200	8,333,300	396,800
1913	9,703,200	8,764,200	417,900
1914	6,710,400	5,997,200	424,300
1915	5,527,600	4,436,700	432,800
1916	5,762,700	4,964,500	489,700
1917	5,461,900	5,055,100	352,000
1918	4,617,300	4,275,400	380,300
1919	4,565,500	3,643,100	289,400
1920	4,693,100	4,556,200	247,400
1921	2,602,400	(a)	347,500
1922	2,771,900	(a)	209,500
1923	3,456,200	(a)	400,300

(a): not available.

The iron ore in Spain is found chiefly in the upper parts of the mountains in rugged and difficult country. Without going into geology too deeply it may be said that the ore usually occurs near limestone beds, which dip steeply, and adjacent to the numerous faults by which these beds are broken up. The deposits vary greatly in position and extent, but generally are so situated that the ore may be opened by quarrying. Relatively little underground mining is done in Spain. In many operations the ore is simply quarried out of the side of the mountain. In other instances considerable overburden must be removed; for instance, at the Luchana mine, near Bilbao, four and a half tons of overburden are handled per ton of ore.

The pits are irregular in shape and without comparison to those in Minnesota, the topography in Spain being exceedingly mountainous and cut up, most of the ore occurring at elevations of more than 2,000 ft. Around Bilbao the ore lies close to the sea, and the approaches to the mining pits are exceedingly steep.

Although some of the mines around Bilbao and Sagunto have much modern equipment, very little shoveling is done mechanically. Most of the ore is dug by hand, the workman using a sort of mattock with which he fills a wicker basket that holds about 37½ lb. In this basket the ore is moved from the face of the quarry or pit to mine cars. Some of the lump ore is handled manually. This rather primitive method is partly a reflection of the different character of the country, which renders the use of even small steam or electric shovels out of the question, and absolutely precludes bringing standard-gage railroad cars into the pits. It is also partly due to the low standard of wages prevailing, it costing less than $1 per ton to put the ore into railroad cars. It probably costs about $3 per ton to put it into ships for export.

The iron-ore deposits of Spain have been carefully studied for many years, and much information is available. According to the mountain ranges, the ore regions are the Cantabrian Cordillera, Sierra Menera, Sierra Fregenal, Sierra Morena, the Pyrenees, ranges west of the Ebro River and those which are on the south coast.

Cantabrian Cordillera—The range of mountains along the northern coast of Spain furnishes more than half of all of the iron ore produced, and the principal deposits are found in the provinces of Lugo, Leon, Oviedo, Santander, Vizcaya, and Alava.

In Lugo province are a series of orebodies, mostly brown hematites and magnetites, occurring associated with schists and other rocks of Pre-Cambrian and Cambrian age. The largest deposits are situated on the west side of the river Vivero; they consist of impure magnetite with an average iron content of 48 per cent. Deposits of brown hematite running 37 per cent iron occur in the vicinity of Villamea, Fonsagrada, and Suarna. At Incio are found three beds at a lower level in the basin of the river Care and two beds at a higher level, extending to Caurel. These deposits are also of brown hematite ore running 50 to 52 per cent iron and low in phosphorus. Several other smaller deposits of brown hematite ore are scattered throughout Lugo Province which contain from 43 to 60 per cent of iron and are usually quite high in phosphorus. L. M. Vidal in 1910 estimated the actual reserve of iron ore in Lugo Province at 122,000,000 tons of 50 per cent ore, the Resources Bureau put it at 120,000,000 tons, and Roesler credits the province with 100,000,000 tons. The additional reserve is estimated at possibly 40,000,000 tons. Lugo Province produces from 200,000 to 300,000 tons of iron ore annually, or about 3 per cent of the total production of Spain.

Table V—Iron Ores of Lugo Province

Locality	Fe	SiO_2	P.	S.	Mn.	Type
Vivero, Juana mine	46.80	17.00	1.46	...	.22	Magnetite
Villamea, Pichoca mine	47.00	34.00	1.30	...	.10	Hematite (a)
Incio	55.00	21.00	.03	.41	...	Hematite (a)
Muras, Peña Ferrena	55.00	19.00	1.30	...	...	Magnetite
Boamonde	48.00	25.50	.03	.14	...	Hematite

(a) Generally calcined.

In Leon Province two different varieties of iron ore are found. The Wagner group of mines between Ponterrada and Astorga have bedded lodes of siderite altered to brown ore. This ore contains from 49 to 52 per cent of iron and 1.60 per cent of phosphorus. The other ore is low grade, containing 32 to 44 per cent of iron and high silica. Two companies are operating several mines in the Wagner deposits, but the production is practically negligible. The Geological Congress estimated the reserve of Leon Province at 166,000,000 tons of 47 per cent ore, and Roesler puts the tonnage in the Wagner group at 25,000,000 tons of high-grade ores and 100,000,000 tons of low-grade ore.

Table VI—Iron Ores of Leon Province

Locality	Fe	SiO_2	P.	S.	Al_2O_3	CaO
Wagner, Hematite	52.35	6.67	.75	.082	.....	.....
Wagner, Siderite	49.04	6.00	.80	.039	.....	(a)
Low-grade ores	44.00	31.00	.13	Tr.	.....	.....
Low-grade ores	39.30	40.00	.34	.030	40.00	40.00

(a) Calcined iron, 56.20 per cent.

In Oviedo Province there are a number of deposits of iron ore of various qualities. Among these is a series of siliceous ores occurring in bedded deposits which are divided into three main groups, the Proaza, the Tererga, and the Carreno. The principal disadvantage that these deposits present is that they lie 20 to 30 miles from the coast and that there are no means of transportation. The ore is a ferruginous sandstone carrying 48 to 60 per cent iron and 15 to 20 per cent silica. At Llanes there are a number of deposits of red hematite and spathic ore, and at Porcia magnetites and hematites rich in manganese have been worked. Roesler estimates the reserve of actual ore in Oviedo Province at 110,000,000 tons and the Stockholm Congress put it at 100,000,000 tons of 47 per cent ore. The possible ore is estimated at 50,000,000 tons. Production of iron ore in Oviedo Province is only about 100,000 tons annually.

Table VII—Iron Ores of Oviedo Province

Ore	Fe	SiO_2	P.	S.	Al_2O_3
Carreno	52.44	15.34	....	.30	4.27
Voaza	48.22	19.77	....	Tr.	5.51
Veina	49.27	16.84	....	....	2.51
Curora	58.10	.....	.011	.016	....
Ostandi	60.00	.....	.072	.126	....

Santander Province is among the three largest producers of iron ore in Spain. The ores are generally good quality brown ores of bessemer grade and lie for the most part close to the sea. The deposits range from 20 to 200 ft. in thickness, and as a general rule there is no overburden. Probably the most important mine in the province is the Obregon, at Cabarga. Here the iron-bearing clay is excavated and sent to the washing plant at Salia, the crude material yielding 20 to 30 per cent of washed ore, which averages 58.80 per cent iron. Other mines are found at Cabarceno, Camargo, Solares, Hoznayo, and Anita. The production of Santander Province is about 1,000,000 tons annually, but the remaining available reserve is put by Roesler at only 20,000,000 tons, approximately, of ore carrying 9,000,000 tons of metallic iron.

Table VIII—Iron Ores of Santander Province

Mine	Treatment	Fe	SiO_2	S.	P.
Obregon	Washed	58.80	3.90	.073	.028
Anita	Crude	47.00	9.40	.062	.030

Vizcaya Province, which includes the famous Bilbao district, is the most noted in Spain and produces from 2,500,000 to 3,000,000 tons of iron ore annually, or about 40 per cent of the total production of Spain. The Bilbao deposits have been the mainstay of the iron-ore production in Spain, but have probably by now passed their maximum productivity. It is estimated that about three-fourths of the original tonnage has been removed. Exports of ore from this district date back to 1860.

The district may be divided into two groups of mines, Somorrostro and Bilbao. The Somorrostro group includes the deposits of Triano, Matamoros, and Galdames; the Bilbao group includes those of Morro, Miravilla, Ollargan, and Iturrigorri. These mines all lie around or within the City of Bilbao. The ore is generally high-grade bessemer hematite, although some limonite and siderite is also found.

Mining is done mostly in open pits and quarries, and, unlike the practice in the rest of Spain, some steam shovels are used in a few mines, though most of the work is done with pick and shovel. Where the overburden is excessive, shafts are sunk and the ore is hoisted in baskets. In recent years large washing plants have been built for treating the huge waste dumps accumulated during the earlier years when only richer ores were exported. Also, the spathic ores are being calcined on a large scale. Although this is the most important iron-ore field in Spain, it is estimated by Roesler to contain only about 35,000,000 tons of assured ore, with a possible 30,000,000 tons additional. The ores from the Bilbao district are shipped to Bilbao and Castro for export.

Table IX—Iron Ores of the Bilbao District

Ore	Type	Fe	SiO_2	P.	S.
Veña	Hematite	56.80	6.21	.015	.016
Campanil	Hematite	52.74	5.20	.010	.014
Rubio	Limonite	51.06	9.75	.024	0.40
Carbonato	Siderite	41.47	6.59	0.17	.140
Carbonato	(Calcined)	56.60	9.53	.015	.040

Pyrenees—Deposits along the southern flanks of the Pyrenees are far less extensive than those of the ranges along the north coast. They occur in the provinces of Guipuzcoa, Navarra, Huesca, Larida, and Gerona.

In Guipuzcoa Province two types of deposits occur. At Certain and Multiloa masses of brown hematite ore are found in the Cretaceous rocks; in many other places there are veins of spathic ore which occasionally carry a varying content of copper pyrites. The outcrops are usually oxidized to brown hematite. Veins of magnetite and specular ore also occur in places.

In Navarra and Huesca provinces similar deposits are found at Vera and at Aneto, Ainhoa, and Bielsa. These are rarely of importance and often lie at considerable elevations in the Pyrenees, making transportation of ore difficult.

In Lerida Province there is a vein of brown ore at Aynet de Besan and Bausen, of siliceous brown ore at Arseguel, and of hematite at Ager. In Gerona Province beds of brown ore occur near Celra, but none of them appear extensive, and no data are available as to the extent to which they have been exhausted.

Iron-ore deposits of the Pyrenees have been imperfectly explored, and little reliable information regarding them is on record, although Roesler estimates an available reserve of 12,000,000 tons of ore, with a possible 4,000,000 tons additional. The ore is usually fairly high in grade, and some contains manganese up to 6 per cent.

Table X—Iron Ores of Aneto, Huesca, in the Pyrenees

	Magnetite	Specular	Hematite
Iron	68.00	66.00	57.00
Silicon	3.50	3.00	3.50
Phosphorus	.104	.....	.020
Sulphur	.300	.....	.....

Ranges West of the Ebro River—The ranges west of the Ebro River are small, and the ore is generally low in grade. Practically no operations are carried on in this region, although several deposits are found in Logrono, Soria, and Saragossa provinces.

In the western end of the Province of Logrono, near Ezcaray, in the Sierra de la Demanda, there are a number of deposits of low-grade red hematite and spathic ores. Roesler considers the ores of this province only as a possible reserve and puts the tonnage at 20,000,000 tons.

In Soria Province there are reported to be small

deposits of low-grade ore near Olvega, but they have not been explored to any extent.

The best ore in the Ebro district is found in Saragossa Province, in the Sierra de la Virgen near Tiegra. It is a high-grade hematite containing about 60 per cent of iron. Roesler estimates the known reserve of this province at 34,000,000 tons.

Table XI—Iron Ores of the Ebro River District

Province	Grade of Ore	Fe	SiO_2	S.	P.	Calcined Iron
Logrono.....	Hematite.....	58.10	15.80	.040	.020	.....
	Spathic.....	37.80	7.40	.040	.008	52.72
Saragossa.....	Hematite.....	65.45	1.70	.020	.013	.....

Sierra Menera—The Sierra Menera lies in the east central part of Spain, and the iron ore deposits are in the provinces of Guadalajara and Teruel. They occur in the form of masses of brown hematite and spathic ores, which at times attain a thickness of 250 ft. Probably some of the oldest operating mines in the world are in this district.

The Province of Teruel contains deposits at Almohaja and at Ojos Negros. Those at Ojos Negros are usually spoken of as the Teruel mines. These are worked by the Sierra Menera Co. and are probably the oldest iron mines in the world.

In Guadalajara Province deposits are found at Setiles, Cerillo de las Colmenas, Pedregal, and El Pubo, in the Province of Guadalajara.

Max Roesler estimates the known reserve of the Sierra Menera district to be 130,000,000 tons and the possible reserve to be 60,000,000 tons.

Table XII—Iron Ores of the Sierra Menera

	Teruel Province Almohaja	Guadalajara Province, Setiles
Iron.....	51.75—57.60	53.32—60.34
Silica.....	2.65— 9.70	1.72— 4.11
Sulphur.....	Tr. — .038	Trace
Phosphorus.....	.06— .39	.01— .17
Manganese.....	1.66— 2.15	1.77—11.3

Sierra Fregenal—In the Province of Badajoz, at Fregenal and Berguillos, there are veins of hematite and magnetite associated with granite and metamorphic sediments. The ore is of good grade, containing from 55 to 66 per cent iron, 3 per cent silica, and up to 4 per cent of manganese, and is very low phosphorus. The reserve of this district is small, being estimated by Roesler at only 7,000,000 tons of actual ore, with an equal amount of possible ore.

Sierra Guadalupe—In the Province of Caceres near Tagus there are lenses of siderite, hematite and brown ore. It is variable in composition, containing from 31 to 58 per cent iron, 0.02 to 12.0 per cent manganese, and up to 0.85 per cent phosphorus, but the deposit does not appear to be of great extent, and little is known regarding it.

Sierra Morena—The Sierra Morena lies north of the Guadalquivir River in the provinces of Huelva and Seville and extends to the Province of Jaen. The principal deposits in Huelva are associated with masses of cupriferous pyrites which have made the reputation of the mineral wealth of this province. A considerable amount of iron is obtained annually from the famous Rio Tinto copper mines, forming the oxidized capping of the lodes of cupriferous pyrites which has been removed in the process of working the latter open cut. Large quantities of this material are available, but on account of impurities it is not very desirable. There is a deposit of bog ore at Mesa de los Pinos near Rio Tinto, which contains about 60 per cent of iron, but the deposit has never been worked. Cala mine, near the boundary of Sevilla Province, is worked by the Sociedad Anonima Minas de Cala. The ore, which is generally magnetite, is hand picked, the portions richest in pyrites being calcined. Roesler estimates the reserve of this province at 324,000,000 tons of ore containing 153,200,000 tons of metallic iron.

In Sevilla Province the most important iron ore deposit is at Monte de Hierro and consists of a series of irregular masses in Upper Silurian limestone with overlying shales. The ore is of good quality, but in parts much contaminated with barytes. Further south, near El Pedroso, there are some deposits of brown hematite, and in the hills of La Lima and Juan Teniente some magnetite is found. Several veins of carbonate ore are reported in the Sierra de Jayona. The reserve of actual ore in Sevilla Province has been estimated to be 36,000,000 tons and the reserve of possible ore to be 18,000,000 tons of 50 per cent ore, but in all probability this estimate is low.

In Jaen Province some lenses of hematite are reported south of Guadalquivir containing little phosphorus and silica, which are now being exploited, but their extent is not yet known, although there is some production.

Table XIII—Iron Ores of the Sierra Morena

	Huelva Province		Sevilla Province			
	Rio Tinto	Mesa de los Pinos	Cala Mines—Selecto	Cala Mines—Corriente	El Pedroso	La Lima
Iron.....	54.48	59.26	60.00	49.53	52.00	55.55
Silica.....	6.72	1.53	8.00	20.85	15.00	15.50
Sulphur.....	1.20	.23	.15	.06	.....	.18
Phosphorus.....	.03	.06	.03	.01	.03	.02

Ranges of the South Coast Large Producers

Ranges of the south coast of Spain include the provinces of Malaga, Granada, Almeria, and Murcia, and outside of the Bilbao district they are the largest producers of iron ore in Spain. The orebodies occur in Triassic sediments and consist of brown, hematite, and magnetite ores.

The famous Marbella mines are in Malaga Province. The ore, averaging over 60 per cent iron, consists of irregular masses of magnetite occurring at the contact of serpentine with Pre-Cambrian dolomite. It is transported to the loading piers by a private railway. On the Sierra del Robledal northwest of Marbella, at Estepona, to the southwest, and at San Mathias, deposits of high-grade magnetite occur. This ore, however, is not as pure as the Marbella ore. Deposits of hematite occur in the Cerro de Monte Corto at Cueva de la Infanta near Almargen and Canete, which average from 50 to 65 per cent iron, but the tonnage available appears to be unimportant. Known reserves of the province of Malaga are estimated at 10,000,000 tons of ore averaging 55 per cent iron.

Table XIV—Iron Ores of Malaga Province

	Marvella	Estepona	San Mathias	Cerro de Monte Corto
Iron.....	61.17	59.25	57.93	64.00
Silica.....	8.65	3.55	9.02	5.00
Sulphur.....	.09	.014	.04	.....
Phosphorus.....	.018	.010	nil.	.013 to .08

In the Alpujarra district of the Province of Granada there are a number of iron ore deposits near the boundary of Almeria, but with the exception of one on the Cerro del Conjuro none are of importance. The ore is hematite, with a little magnetite. Cerro del Conjuro mine is the largest in the province, and is said to contain over 5,000,000 tons of brown hematite ore carrying 40 per cent iron. Other deposits are found around Orgiva, the Tablete group, the Tesorero mines

in the Sierra de Baza, and in the neighborhood of Loja. The reserve of actual ore in Granada is estimated at only 17,000,000 tons running 50 per cent iron.

Table XV—Iron Ores of Granada Province

Type of ore	Berchules Magnetite	Cerro del Conjuro Hematite	Orgiva Hematite	Tablete Hematite	Tesorero Hematite	Loja Hematite
Iron	52—59	40.00	55.00	40.00	61.32	55.00
Silica	7—16	4.50	10.00	4.50	6.40	10.00
Phosphorus	.04—.01	.025	.004—.04	.015	.010	.03
Sulphur	.05—.07	.06	.....	.01	.....	.20

The Province of Almeria is the largest producer of iron ore on the south coast and ranks next to the Bilbao district. This province ships more than half a million tons of ore annually. Deposits are found at Bedar and Chive, in the Sierra Cobrera and Sierra Alhamilla, and at Bacares, Menas, Macael, Alcudia, Cantas, Olula, and Gergal. Undeveloped orebodies occur in the Sierra de Filabres and at Beires. Reports from the developed districts show that they contain ore running 50 to 57 per cent iron and very low in phosphorus. The Gergel district mines are operated by the Soria Mining Co. and the Salobral company.

The orebodies are lenticular in shape and contain spathic ore averaging 55 per cent iron. Similar deposits are worked in the Olula and Macimiento districts. The Soria company also operates deposits of brown hematite ore at Beires and in the Sierra de Basa which are frequently manganiferous. The Alquife orebody occurs in the form of an extensive flat-lying deposit in the plains at the base of the western end of the Sierra Nevada. The ore is of good quality, but is so fine that it requires briquetting or sintering before it is suitable for furnace use. Bacares, Seron, and Menas districts contain spathic and brown hematite ore running 45 to 55 per cent iron. Menas mine alone is said to contain about 4,000,000 tons of ore. In the Sierra Alhamilla and Sierra de Bedar there are numerous deposits, the best known of which are Porfiado and San Manuel, from which Garrucha ore is shipped. In the Sierra Almagro the ore is principally magnetite. A grade of ore known as Villaricos is shipped from this district. Reserves of Almeria Province are estimated at about 70,000,000 tons of actual ore averaging better than 50 per cent of iron, and 24,000,000 tons of possible ore.

The principal ore deposits in the Province of Murcia occur near Cartagena. The ore occurs in the Triassic rocks and some of it carries as much as 26 per cent manganese. Other deposits are found at Lorca, Morata, Porman, Cieza, and Cehegin. The ores are mainly spathic oxidized to brown hematite at the outcrop. A considerable quantity of ore is produced in this province, although none of the deposits are very large. The largest are thought to be those at Cehegin, in the district of Calaspara. Reserves of this province have been put at 25,500,000 tons of known ore and 10,000,000 tons of possible ore.

Table XVI—Iron Ores of Almeria Province

	Gergal	Olula de Castro	Bieres	Sierra de Baza	Alquife	Menas	Garrucha	Villaricos
Iron	55.00	57.90	52.82	58.00	52.50	48.38	55.00	46.50
Silica	7.00	7.93	9.64	3.50	5.00	5.98	6.00	6.00
Phosphorus	.01	.013	.029	.055	.014	.008	.016	.20
Sulphur	.09	.....	.032	.05	.036	.015	.073	.60
Manganese	.....	1.07	2.60	.....	1.70	1.58	2.50	7.50

Table XVIII—Iron Ores of Murcia Province

	Cartagena Red Ore	Cartagena Manganiferous	Morata	Cehegin
Iron	40—43	35.00	50.00	56.00
Silicia	10—12	11.00	4.50	8.00
Phosphorus	.....	.....	.02	.15
Sulphur	.....	.....	.02	.26
Manganese	.80	12.00	2.00	.30

Various estimates of the iron-ore reserves of Spain have been made from time to time, but they usually include only certain districts and do not cover the entire country. Table XIX gives some of the reserves that have been given since 1905.

Table XIX—Iron Ore Reserves of Spain

Region	Province	Actual Reserve	Possible Reserve
Cantabrian	Lugo	122,000,000	40,000,000
Cordillera	Leon	166,000,000	.....
	Oviedo	110,000,000	50,000,000
	Santander	20,000,000	.....
	Vizcaya	35,000,000	30,000,000
Pyrenees	Guipuzcoa	12,000,000	4,000,000
West of Ebro	Logrono	.....	20,000,000
	Saragossa	34,000,000	.....
Sierra Menera	Teruel	130,000,000	60,000,000
Sierra Fregenal	Badajoz	7,000,000	7,000,00
Sierra Morena	Huelva	324,000,000	.....
	Sevilla	36,000,000	18,000,000
South Coast	Malaga	10,000,000	.....
	Granada	17,000,000	10,000,000
	Almeria	45,000,000	24,000,000
	Murcia	25,500,000	10,000,000
	Totals	1,117,500,000	273,000,000

Spain is favored in having her deposits of coal and iron ore in the Basque and Asturian provinces in such close proximity and also in having abundant water-power resources, while ready access to the sea affords means of easy and cheap transportation.

During the Great War the production of iron ore in Spain continued at a high rate, owing to the demands of Britain and France, but after the war it dropped off, owing to shortage of capital and mining equipment. In recent years many new companies have been formed in Spain and several new plants have been started, so that it should not be long until the production of iron ore reaches what it formerly was. At present there

Table XVII—Analyses of Various Iron Ores Shipped from Spain

	Analysis—Dried At 212 Deg. F.								
Trade Name of Ore	Fe	P	Mn	SiO_2	Al_2O_3	CaO	MgO	S	Moisture
Beires	51.29	.015	2.66	8.20	3.71	.80	.32	.022	....
Berastegui	55.15	.007	6.53	5.70	1.00	1.70	1.62	.796	....
Bilbao	56.29	.010	1.00	8.65	....	2.00	3.96	.450	1.50
Calasparra	57.10	.427	Tr.	8.23	2.45	1.85	5.06	.082	2.50
Camargo Washed	56.08	.056	.50	5.80	.80	.36	.38	.260	5.85
Cartagena Colorado	44.70	.019	4.62	10.05	2.05	1.03	.65	.165	11.25
Cartagena Limey	47.12	.017	1.22	11.05	1.09	4.64	.75	.260	....
Cartagena Manganese	33.21	.018	12.16	9.06	2.11	4.50	1.08	.112	....
Donata	53.00	.150	2.24	6.55	2.50	1.20	.79	.030	5.65
Garrucha (calcined)	59.84	.060	.11	5.21	3.30	2.10	.73	.110	....
Gergal-Soria	55.05	.024	1.50	7.90	1.95	.80	.95	.040	....
Garrucha Manganese	40.68	.044	12.45	5.64	1.36	2.65	.38	.133	....
Huelva	55.00	.030	.20	12.00	4.50	.50	.70	.150	1.50
La Calera Limey	50.85	.015	1.35	3.38	.33	9.10	.79	.043	....
Lucainena	51.57	.009	3.95	9.10	.97	2.94	3.16	.813	.34
Marbella	53.00	.010	Tr.	13.00	1.35	.55	6.85	.236	....
Marqusando	55.60	.018	1.80	4.70	.60	5.50	.23	.025	9.40
Monte Hematite	54.14	.017	1.08	8.25	1.48	1.35	.32	.200	....
Porman "C"	48.98	.027	.84	13.15	2.62	.62	1.90	.285	5.08
Rivadeo Cale	48.00	.626	.11	18.50	7.78	.68	.41	.091	....
Seco Primero	49.20	.034	.90	11.15	2.30	1.05	.87	.396	....
Setares	52.00	.041	Tr.	9.60	2.19	.50	Tr.	.036	7.17
Tiergo	55.65	.022	Tr.	4.80	2.33	3.21	2.08	Tr.	2.87
Villaricos	53.46	.018	2.33	7.90	1.76	Tr.	.13	.698	....
Vivero	45.58	1.200	.30	18.05	5.49	4.82	1.15	1.050	....

are between twenty-five and thirty blast furnaces in Spain. Most of the industry is in northern Spain around Bilbao, but with the exhaustion of the ores of these provinces it will have to depend on the ores of Teruel and Guadalajara, although this will probably be far in the future.

Table XX—Various Estimates of the Iron Ore Reserves of Spain

Estimated by	Year	Actual Reserve	Potential Reserve
Tornebohm	1905	500,000,000	.....
Sjogren	1910	711,000,000	.....
L. de Adaro	1912	881,000,000	1,500,000,000 (a)
E. C. Eckel	1914	711,000,000	.....
A. C. Spencer	1918	700,000,000	.....
F. H. Hatch	1920	650,000,000	.....
Max Roesler	1921	954,500,000	373,000,000
O. R. Kuhn	1925	1,117.500,000	273,000,000

(a) Ores containing 25 to 35 per cent iron.

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Who Makes Chile's Mining Machinery?

Chile is an important mining country, and, therefore, a good market for manufacturers of mining machinery. The United States supplies more than half of all that is used, according to Ralph H. Ackerman, in the Jan. 11 issue of *Commerce Reports*, though competition from both British and German sources is steadily increasing. This is especially noticeable among the smaller mining companies where units are small and price differences are the deciding factor. Likewise, as many of the nitrate companies have their own purchasing offices in London or buy through the intervention of British commission concerns, most of their equipment is supplied by Great Britain, and slight inequalities of price or performance are immaterial. There is, however, a growing disposition to give greater consideration to operative economies wherever appreciable savings can be demonstrated.

The quantity of rock drills imported during 1925 probably exceeded that for 1924, not alone for use in the copper mines but for the nitrate fields, as the steadily mounting nitrate sales have resulted in the operation of a high percentage of the nitrate plants. Practically all such drills come from the United States, the supply in 1924 totaling 354 and the value being $65,930.

Ore-crushing and sorting machinery is almost entirely of American origin, and as yet none of the European manufacturers has made a serious effort to meet this competition. As this is one of the largest items of mining machinery which comes from the United States, continued predominance in this line will contribute largely to the maintenance of the American position during 1925. In 1924, according to official American statistics, a total value of $466,395 in ore-crushing machinery was exported from the United States to Chile. While in the nitrate fields crushers of British manufacture are in evidence, most of the new equipment of this type that is being installed is of American origin, and as heavy purchases were made by all of the American-owned copper mines and by several other mines, imports for 1925 will doubtless be above those for the previous year, despite the fact that a number of the orders placed are for shipment during 1926.

Centrifugal pumps were in little demand during the last of 1925. Quantities imported during 1925 will, therefore, be somewhat lower than during the preceding year. American pumps of this type are well received and have little competition from European manufacturers. British centrifugal high-head pumps have had some success, but prices are now out of line with those of American manufacture and only infrequent orders are obtained by representatives of British or Continental manufacturers.

On the other hand, steam pumps are largely of European origin. Swedish manufacturers are offering presentable and serviceable pumps closely resembling American designs between 30 and 40 per cent below American prices. Though heavy American capital investments and engineers' preferences will prevent the elimination of United States manufactures, price adjustments are necessary if participation is to be increased. The British predominate in the nitrate fields but they are likewise feeling the effects of the entry of Sweden. A few Swiss and German steam pumps enter from time to time, but their share of the business is small.

An active demand was apparent throughout 1925 for air compressors, and three of the large copper mines have placed sizeable orders with American manufacturers. It is believed that between 80 and 90 per cent of the air compressors purchased during 1925 have been from the United States. An estimate of quantities imported is about $150,000, or slightly in excess of that for 1924.

Heavy demands for machinery from the mining companies are expected in 1926. As the Chilean Government will guarantee the interest and amortization of foreign capital to be invested in a local hydro-electric steel industry, involving an expenditure, over a period of two years, of approximately $4,500,000, of which $3,000,000 is to be spent abroad for equipment, and as this loan will probably be absorbed in the United States, a large part of the orders may go to this country.

Will Make Sponge Iron in Japan by Thornhill-Anderson Process

Negotiations have been completed between Thornhill & Anderson, of West Allis, Wis., and Goro Matsukata, for the sale of the Japanese rights to the process of making sponge iron developed at the plant of the Chino Copper Co. a few years ago. The first unit of a commercial plant is now being designed and manufactured. This will have a capacity of from 70 to 100 tons of sponge iron per day. The process will utilize a titaniferous iron ore containing between 35 and 45 per cent iron, using a low-grade lignite as fuel and reducing agent.

Commercial development of the Thornhill-Anderson process, and publication of the technical details, has been held up in the United States, owing to litigation over patent rights.

Discussion

Genesis of Sulphide Ores

THE EDITOR:

Sir—I am surprised that the important article on "The Genesis of Sulphide Ores," by Horace Freeman, in the *Mining Journal-Press* for Dec. 19, 1925, has not led to more discussion. It may be because others, like myself, wished to digest it at leisure, or have been awaiting the result of further studies. Mr. Freeman's researches certainly open up a possibility that in some cases, if not in all, the decomposition of alkaline sulphide melts with metallic sulphides may have produced the sulphide ores which are the object of mining. His theory would help to account for the deposition of sulphide ores in fissures, within the limits of depth where they are usually found.

It would seem to me that our conceptions of the nature of the agencies which deposited sulphide ores in fissures may be tested by the known effects when the same fissures traverse stratified rocks, replacing some of them in preference to others. Limestones, for instance, are replaced more readily than sandstones or shales; and the limestones themselves in the order of their relative purity. What is the relative facility with which Mr. Freeman's double sulphide melts would attack such rocks?

There can be little doubt, where we find a succession of limestone beds intercalated with sandstones and shales, all intersected by mineralizing fissures, which have replaced the limestones in preference to the other sedimentaries with sulphide ores, that the sulphide ores are primary, and came up through the fissures. Why is the limestone usually replaced? It would be helpful if Mr. Freeman would ascertain for us the relative rate of attack, at various temperatures, of limestone, sandstone, and similar rocks, by melted sodium sulphide with sulphides of iron, lead, and zinc. The silica in the melt may have been supplied by the rock walls; for we usually find more quartz in the fissures, especially where they intersect siliceous rocks, than in the limestone replacements.

Mr. Freeman states, "In the case of these double sulphides, which are soluble in their entirety, precipitation is effected by natural oxidation of the sodium sulphide portion."

May this not, perhaps, account for something which we have observed at Rico—namely, that the replacements in and adjacent to the wider and more open fissures consist mainly of pyrite, which may be due to the fact that these fissures were permeable by oxidizing waters from the surface? Such fissures themselves usually contain only pyrite and quartz. At a greater distance from these fissures, or adjoining the smaller and tighter ones (where the waters may have contained little or no dissolved oxygen) we find the lead-zinc-iron mixed sulphide replacing the limestone.

The theory of zonal distribution of ores has been badly overworked, and I doubt very much if the elaborate succession claimed by W. H. Emmons and others can be substantiated. It is true, I believe, that there is a general tendency for a succession from iron-copper to zinc-lead and lead, and also (in Cornwall) one from tin to tin-wolfram and thence to copper. There is evidence that some sulphide veins cease to contain quartz and sulphides in depth, and that other veins contain no sulphides close to the original surface at the time of deposition. But that such relatively small changes of temperature as are likely to be found within range of a few hundred feet can satisfactorily account for such zonal distribution of ore as is actually observed I strongly doubt; and when we see a similar, but horizontal, zonal arrangement varying with distance from the source of mineralization, within a range which renders change of temperature quite impossible as an explanation, it seems necessary to look for some cause of more general applicability.

I have never felt quite satisfied to attribute zonal distribution of ores to drop in temperature, for there seems to be in some cases a horizontal or perhaps concentric distribution (for example, in Gilpin County, Colo.—see the *Transactions* of the Institution of Mining and Metallurgy, Vol. XII, pp. 480-495—where there is no apparent reason for any change in temperature).

I think it more plausible to attribute the zonal deposition to a difference in the relative rate of decomposition of Mr. Freeman's double sulphide melts, in the presence of air and water. But this hypothesis is equally unable to explain horizontal changes, such as that of Gilpin County.

Where we find zonal changes varying with distance from igneous masses, as in Cornwall, it may be attributed to the unequal heating of the surrounding rocks; but even in this case it seems difficult to suppose that the clay-slates can have been heated to the necessary temperatures at such great distances from the igneous rocks to which the effect is attributed.

The greatest difficulty in explaining ore deposition, to my mind, arises from the fact that it is not always possible to distinguish sharply between the veins which appear to have been filled by attenuated solutions and those which were filled by viscous ones; or, again, between filled fissures and replacement fissures; so that one is not able to admit two or more distinct and independent hypotheses of origin. One and the same fissure must have contained "solutions" which at one place readily attacked limestone or limy shale, and at another place (but less readily), sandstone, quartz-porphyry, or even quartzite, so that it is incumbent on the physical chemists to find for us "solutions" that are competent to produce the observed results. The idea which is suggested by Mr. Freeman's experiments—namely, that part of the "melt" may have been precipitated by water in a colloidal form, leaving the rest in the form of thin solution (which, moreover, usually had been robbed of most its ore constituents)—seems to me to afford a possible basis for a satisfactory theory.

Denver, Colo. GEORGE E. COLLINS.

Magazine Explosions

THE EDITOR:

Sir—In your issue of Feb. 13, on page 274, I have read with a good deal of interest the editorial "United Verde Magazine Explosion" and the deductions reached. As a matter of information to your readers and users of explosives, explosive manufacturers do not recommend the use of a storage magazine as a thawing house, because of the risks involved.

It is considered safer practice to thaw explosives in a separate building located sufficiently far from the magazine, inhabited buildings, and other structures, so that should the thawing house explode, it will not do serious damage. A thermostat or some type of heat regulator should absolutely control the temperature in the thawing house, so that it could not rise above approximately 90 deg. temperature. Wooden floors, inside lining, and the type of construction that in the event of an explosion would result in a minimum number of missiles is the safest type of magazine, provided the magazine be bullet- and weather-proof, fire-protected, and ventilated to suit climatic conditions.

I have taken the liberty of offering the foregoing suggestions because many years' experience has proved that they will insure a maximum amount of safety in the storage of explosives, provided the necessary safety rules in operating the magazine are observed.

Wilmington, Del. EDWIN B. JONES.

Consultation

Carbon Monoxide Poisoning

"Can you tell me the ill effects of carbon monoxide, found in so many mines, on the human system?"

Carbon monoxide exerts its extremely dangerous action on the body by displacing the oxygen from combination with the hemoglobin. Hemoglobin, the coloring matter of the blood, normally absorbs oxygen from the air and delivers it to the tissues through the blood. The affinity of carbon monoxide for hemoglobin is about 300 times that of oxygen. Because of this, even when only a small amount of the poisonous gas is present in the air breathed into the lungs, much of the hemoglobin is locked up in combination with carbon monoxide and so cannot keep up its usual work of carrying oxygen to the tissues. These, because of the lack of oxygen, cannot do their work properly. If they are smothered long enough, the tissue cells become damaged, and the injury to the cells may be permanent even if the patient survives. It has been asserted that carbon monoxide has a specific poisonous action on some tissues of the body, especially those of the nervous system, but there is little evidence in favor of this statement and much against it, according to R. R. Sayers, chief surgeon for the U. S. Bureau of Mines.

With increasing concentrations of carbon monoxide, the time required for a given amount of hemoglobin to combine with carbon monoxide would decrease very rapidly, until with 1.0 per cent it may require only time enough to take a few breaths to produce a saturation of 60 to 80 per cent, which is fatal.

The symptoms of carbon-monoxide poisoning may be divided into two stages, the first covering the period beginning with normal and ending in syncope, and the second a depression of the central nervous system beginning in syncope, extending through coma, and ending in apnea.

Stage 1. Tightness across forehead, dilatation of cutaneous vessels, headache (frontal and basal), throbbing in temples, weariness, weakness, dizziness, nausea and vomiting, loss of strength and muscular control, increased pulse and respiratory rates, collapse. All of these are greatly increased and accelerated with exercise on account of the additional need of oxygen in the tissues. Men at rest have often been exposed to carbon monoxide all day without noticing any marked ill-effects, but on walking home or exercising have experienced severe symptoms, even to unconsciousness.

It is seldom that all of these symptoms are experienced by the same individual. Also, in some cases the poisoning may proceed to the stage of syncope without the victim feeling any of the subjective symptoms, this frequently occurring if the poisoning has been rapid.

Stage 2. Increased pulse and respiratory rates, fall of blood pressure, loss of muscular control, especially sphincters, loss of reflexes, coma usually with intermittent convulsions, Cheyne-Stokes's respiration, slowing of pulse, respiration slow and shallow, cessation of respiration, death.

With a given blood saturation, the character and severity of symptoms acquired during exposure depend upon the time required to attain that saturation and the degree of muscular activity—in other words, the extent of oxygen deprivation. The number of symptoms decreases with the rate of saturation. With high concentrations the victim may experience but few (weakness and dizziness) of those given under the first stage of symptoms. If a given saturation has been acquired by a long exposure to a low concentration, the symptoms and after-effects will be a great deal more severe than will ordinarily be experienced by a comparatively short exposure to a high concentration. Muscular activity increases the number and accentuates the character of the symptoms during exposure, and will bring out latent symptoms after exposure. A person at rest may pass into a state of dizziness and unconsciousness without experiencing any marked previous effects.

The after-effects of carbon monoxide poisoning range from practically none to headaches, muscular pains, long periods of unconsciousness, loss of strength, and mental derangement, such as loss of memory, paralysis, and temporary blindness. In nearly all cases these clear up in a day or two, but there are cases where they have extended over several months, and, in a few instances, over years. The possibility and severity of these depend upon the duration of oxygen deprivation, personal idiosyncrasy, and physical condition before exposure. Slight exposures to high concentrations cause far less tissue damage than long exposures to low concentrations, the effect of oxygen deprivation being additive. With some men there is a specific tolerance to this deprivation, and therefore they may experience little or no after-effects from exposures which are serious to fellow workmen. It is very probable that much of this idiosyncrasy is due to previous health condition, and that many diseases, as cerebral arterio-sclerosis, syphilis, and acute alcoholism, are contributory to serious sequelae.

Prohibition in Mining Districts

THE EDITOR:

Sir—In scanning *Mining Journal-Press* for the last two years or so for certain articles, I reread your editorials and answers to the questionnaire on prohibition in mining districts. These reminded me that the town of Waihi, New Zealand, recently voted to return to the sale of liquor, after being dry for seventeen years. I have not heard of the underlying cause of this reaction, but at its last general elections New Zealand had a much larger majority to remain wet than at any previous election. When I worked at Waihi, in 1895-1899, a huge quantity of liquor was consumed. Some of the millmen who worked around the drying kilns, dry-crushing stamps, and at dumping the crushed ore into cyanide vats drank beer to dissolve the dust—at least, that is what they said while imbibing.

Waihi is still much on the map and the Waihi mine is the greatest silver-gold producer in New Zealand and one of the world's noted mines, producing £330,000 ($1,600,000) per annum at good profit and high extraction. An incentive to contented living by company employees is a beautiful sea beach within thirty minutes by automobile. M. W. VON BERNEWITZ.

Pittsburgh, Pa.

Uniform Federal Regulation Needed Instead of State "Blue-Sky" Law

THE EDITOR:

Sir—Many phases of "blue-sky" legislation and its destructive effect toward development of new mineral areas of the West were ably set forth under "Discussion" in the Jan. 23 issue of *Mining Journal-Press*. Yet volumes could be written in discussion of the subject and perhaps we should still get nowhere. The fact remains that the selfish instinct exists in mankind now as always before—greed which knows no bounds or limitation unless curbed by fear of the consequences. This curbing has been attempted by the enactment by various state legislators of "blue-sky" laws which, in most cases, instead of remedying the evil have resulted in their becoming walls of discrimination, industrially separating the more populated states from those of lesser population, but having greater undeveloped areas of natural resources, with the result that they are separating the mutual interests of people—east from west and north from south, and creative sentiments and customs more becoming to a group of small hostile nations.

From the fact of our being so familiar with that primitive and modern instinct of man (greed), and knowing that it can be held in abeyance only through infliction of severe penalty, why should we not have a short form of federal regulation, providing positive infliction of penalty in all convictions for misrepresentation as to the physical condition or value of any enterprise, mine assays, lands, stocks, bonds, or other property or security seeking or soliciting financial support?

However, before such laws could be made effective, we must remove the law-enforcing bodies from all political affiliations and make them independent of any and all political or religious influence.

Though no law should attempt to dictate what the public should or should not speculate in, it should positively insist upon truthful representation and that all enterprises be constructively within the laws of the country. Such uniform law, governing all people and localities alike, would prove the most effective fuel for kindling the flame of respect, honor, and confidence between fellow citizens, because such sentiments must live if all localities are to measure up to a reasonable standard of useful pursuits. V. A. TAMNEY.

Reno, Nev.

Meteor Crater

THE EDITOR:

Sir—I note with considerable interest that the old Meteor crater, near Winslow, Coconino County, Ariz., has so far failed to show any evidence of a meteor underlying it. I examined that area five years ago and prepared a paper for the Chamber of Mines and Oil *Bulletin* of Los Angeles on the subject, but it was not published.

The so-called Meteor crater, so far as I can see, is a big hole in the heart of a perfect elliptical shaped dome in sedimentary rocks, limestone, sandstone, and shale. The hole in the heart of this dome can be explained as due to solution of the underlying gypsum, salt beds, and limestone beds which occur in the Supai and Red Wall formations, which underlie the Coconino sandstone, which, with the Kaibab limestone, forms the sides of the crater.

Numerous sink holes occur in this area, due to solution of the underlying gypsum, salt, and limestone beds. The top of a dome would form an ideal place for solution and drainage away from the dome. That there is underground drainage is clearly evidenced by the fact that water does not accumulate at the bottom of the crater.

So far as I can see there is no evidence pointing to either volcanic action or to meteoric action. Meteoric fragments are quite common in that part of Arizona and not confined to Meteor crater. DORSEY HAGER.

Seattle, Wash.

Lead, Iron, and Cadmium in Zinc

THE EDITOR:

Sir—In the method given for the determination of lead, iron, and cadmium in slab zinc in your issue of Dec. 26, 1925, the line reading "If the filtrate contains much cadmium, over 0.01 per cent," should read "if the filtrate contains much cadmium, over 0.10 per cent; that is, several tenths of one per cent." A standard should be run with the sample precipitating the same amount of cadmium as is in the sample, or precipitating 50 milligrams of cadmium, as the quantity of cadmium precipitated is proportional to the amount taken. The solution before precipitating should be neutralized with ammonia and then made slightly acid with two or three drops of sulphuric acid.

The specifications for zinc given by the American Society of Testing Materials, 1911, are:

	Lead, Per Cent	Iron, Per Cent	Cadmium, Per Cent	Total Not Over, Per Cent
A. High-grade	0.07	0.03	0.05	0.10
B. Intermediate	0.20	0.03	0.50	0.50
C. Brass special	0.75	0.04	0.75	1.20
D. Prime Western ..	1.50	0.08		

The methods given are not applicable to determining very small percentages in high-grade metal.

Donora, Pa. JOHN H. HASTINGS.

bury; and one of the Cobalt mining companies is reported to be about to start exploratory operations on a zinc prospect near Renfrew.

A most promising new source of zinc in eastern Canada is the gold field of northwestern Quebec, where zinc in the form of sphalerite is found associated with the copper-gold ores. Interest in this new field, however, has been so fixed on the more valuable metals, gold and copper, that little attention has as yet been given to its further possibilities as a producer of zinc.

Operations at Old Peck Mine to Be Resumed

Operations are to be resumed at the old Peck mine, in the Bradshaw Mountains of Arizona. The Peck mine was closed down about twenty years ago because expensive milling methods of those days made it impracticable to work the low-grade ores. With modern mining methods and machinery, however, the owners expect to work over the old dumps and resume mining and milling operations on the property.

Old Vulture Mine to Be Reopened Soon

Reports are to the effect that the old Vulture Mine, at Wickenburg, Ariz., is to be reopened in the near future, with A. G. Simpkins, engineer, in charge of the work. The underground workings have been closed down since about 1914. Workings to a depth of 1,239 ft. have been run, generally following the hanging wall side. The footwall side has not been thoroughly explored.

During the last three or four years, a San Francisco company, headed by R. P. Beals, as resident manager, installed a cyaniding plant for treating the 250,000 tons of tailings from the old Vulture mill, and dumps which the company leased, and handled about 250 tons daily. The content of the tailings is reported as about $2 per ton, of which approximately a 95 per cent extraction, at a cost of 50c. per ton, was obtained. This work is now almost completed.

Chloride, Ariz., to Have Custom Mill

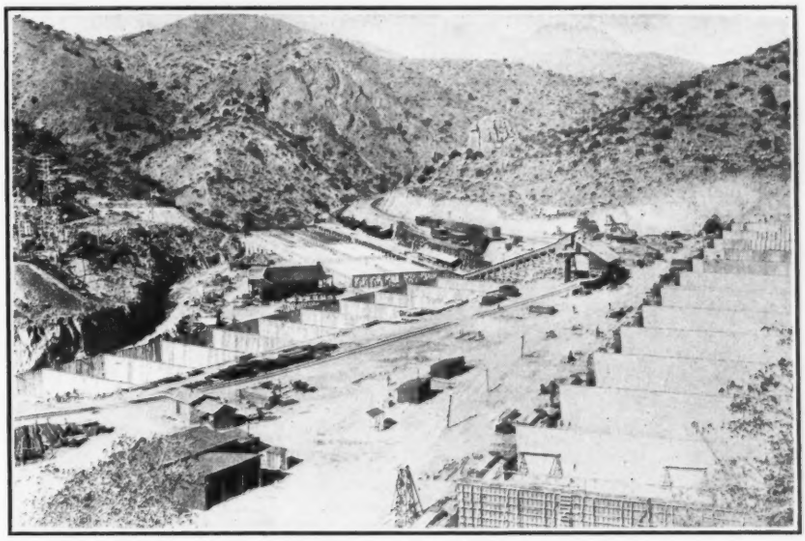
Ground has been broken at Chloride, Mohave County, Ariz., for the construction of a 150-ton custom mill, by the Chloride Mining Co., operators of the Hidden Treasure mine. The new mill has been designed to treat the zinc-lead ores of the Chloride district by selective flotation. A 5x10 rod mill and two seven-cell flotation machines have been purchased and shipped to Chloride. The building has been laid out on a scale sufficiently large to allow the capacity to be enlarged from 150 tons to 300 tons per day.

The Katherine Gold mine, near Oatman, has increased its output from 150 tons to 200 tons per day. Shipments of bullion are being made from the property every ten days. The cyanide plant of the Gold Dust mine, at Oatman, is expected to be in operation within thirty days.

Leaching Plant of Inspiration Consolidated Copper Co.

A photograph of the leaching plant of the Inspiration Consolidated Copper Co., under construction at Miami, Ariz., is shown herewith. At the right are the tanks. It will be noted that those in the distance have already been lined with lead. Opposite the leaching tanks are the solution tanks, from which the solution used in the leaching process will be pumped into the leaching tanks. These solution tanks are completed.

In the middle distance is the central concrete mixing plant, which has supplied the concrete for the entire job to date. Below the mixing plant is the foundation for the tank house. There are 720 concrete posts in this foundation, and the building will be more than 500 ft. long. The tunnel shown at the end of the leaching tanks extends 325 ft. into the hillside and is a track extension for ore cars. In preparing the site for the plant approximately 325,000 cu.yd. of dirt was moved.



Leaching plant of Inspiration Consolidated Copper Co. under construction at Miami, Ariz.

Shannon Mine Fills With Water

Shannon copper mine, at Gleason, Ariz., has been allowed to fill with water for the purpose of extinguishing the fire which was started in the sulphide orebodies two years ago. The burning and flooding were part of an experiment to determine if such procedure would render the ore susceptible to extraction by leaching.

Survey Planned for 12-Mile Railway to Monte Cristo Mine

A survey, preliminary to the construction of a railroad, from Wickenburg to the Monte Cristo mine, 12 miles northeast of Wickenburg, Ariz., is to be made within the near future, according to announcements made by Ezra Thayer, of Phoenix, president of the Monte Cristo company. Arrangements for the survey have been completed between Mr. Thayer and the Santa Fe Railroad Co.

The Monte Cristo mine, it is reported, is one of the most promising properties in the state. For several years the property has been in course of development by Ezra Thayer. It has not yet produced commercial ore, although rich orebodies have been blocked out. The ore runs high in silver, and the commercial copper ore also contains considerable gold, it is said.

Plans are now being made to install a mill at the mine, and reports are that negotiations for its construction will be entered into in the near future. The shaft has been sunk to the 1,100 level, and it is planned to sink it 400 ft. deeper. About 20,000 ft. of drifts, crosscuts, and raises have been driven in the mine.

Globe Mine to Be Reopened

The Globe mine, near Dedrick, in Trinity County, Calif., is to be reopened again after several unsuccessful attempts to operate. The property was equipped in 1912 with a mill and cyanide plant. Bulkeley Wells operated the mine for a short time, but without success, in 1920. It was then closed down and the equipment dismantled and sold, the mining property being subsequently acquired by other parties. Apparently, local people of Weaverville are interested in the attempt to resume operations.

New Device Reported to Have Located Meteorite Near Winslow, Ariz.

Using a specially built radio apparatus of his own invention, William A. Sharpe claims that he has definitely located the great meteorite which is believed to lie near Meteor Mountain, between Flagstaff and Winslow, Ariz., at a depth of approximately 1,400 ft. and every indication points to its being of enormous size and almost entirely of iron.

Though similar in some respects to the devices commonly used in attempts at mineral location, the Sharpe instrument, which is called the "radio camera-phone," is claimed to be capable of determining not only minerals but also the several classes of rock to a depth of about 5,000 ft.

News of the Week

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Summary

ARIZONA UNIVERSITY is to give a graduate course in mine administration—Iron Cap Mining Co. to resume operations at mine and mill—Chloride constructing custom mill.

British Guiana exported 174,999 long tons of bauxite and $4,057,285 worth of diamonds in 1925—Dutch Guiana 85,525 metric tons of bauxite.

Consolidated Lead & Zinc Co. becomes important factor in Joplin-Miami as it increases its holdings—Golden Rod acquires additional acreage.

Snowslide at Bingham, Utah, in which many are killed; property damage at least $40,000.

New evidence presented in Carson patents case.

Airplane service for Red Lake area, Ontario—McDougall-Cassell property sold—West End Consolidated discovers new ore in "76" vein—White Caps to sink deeper.

British Columbia mines produce $66,526,074 in 1925—Noranda issues progress report—Zinc possibilities in eastern Canada.

Organization of African Metals Corporation completed to represent three Belgian companies operating in Africa.

Old Vulture mine, in Arizona, to be reopened—Shannon mine fills with water, preliminary to leaching.

Platinum continues to be topic of interest in South African technical and financial circles.

Organization of African Metals Corporation Completed

To Be the American Representative of the Three Belgian Companies Operating in Africa

By the organization of the African Metals Corporation under the laws of New York State, the allied group of Belgian metal interests known here as the Union Minière du Haut-Katanga, the Société Générale des Minerais, and the Société Générale Metallurgique de Hoboken, Belgium, are consolidating their activities in America, as they have done already in France, Germany, Italy, Spain, Mexico, and elsewhere, by the formation of similar subsidiary companies. The Union Minière is the producer of "Katanga" copper in the Congo. It also produces cobalt in large quantities and has a growing production of tin. The Société Générale des Minerais is the selling agent for copper and tin for Union Minière in the world markets and in addition is an important factor in the European zinc, lead, and chemical markets. It also acts as a buying agent for numerous affiliated companies.

M. Emile Francqui, State Minister of Belgium, is chairman of the African Metals Corporation. F. Pisart, managing director of the Société Générale des Minerais and the Société Générale Metallurgique de Hoboken, is the president. G. F. Creveling, of New York, is secretary and treasurer. Other directors include Edgar Rickard, mining engineer, New York; Edgar Sengier, administrateur-directeur of the Union Minière du Haut-Katanga, Antwerp, Belgium; and Gustave Lechien, manager of Union Minière du Haut-Katanga; Camille Gutt, managing director of Cuivre & Metaux Rares, Paris, France; Victor Cohner, manager of metal sales, Société Générale des Minerais, Brussels, Belgium, and Victor Mikolajczak, managing director of the Union des Usines à Zinc, Liége, Belgium.

Raymond Luber will be manager of the cobalt sales in America. Edmond Rommel, technical buying agent for the Société Générale Metallurgique de Hoboken, also is attached to the African Metals Corporation, with offices at 25 Broadway, New York City. Louis Hirshler has been chosen by the Belgian group to act as technical advisor to the African Metals Corporation.

Consolidated Lead & Zinc Shares Ready to Be Issued

Terms for the exchange of stock in the Consolidated Lead & Zinc Co., as a result of its merger with the Underwriters Land Co., have been announced. For each share of stock in the old company one-third share of B and 1⅛ shares of Class A stock will be given in the new company. Opportunity to buy or sell fractional parts to make even shares is given stockholders on the basis of $27.50 per share for both classes of stock.

Authorized issue of A stock totals 275,000 shares, of which only 175,000 shares will be issued now. The total of B stock is 25,000 shares, of which all will be issued, the majority going to the Eagle-Picher company. Voting power will be vested exclusively in Class B stock.

The new stock is ready for issue, and stockholders have been notified to send their certificates to the American Trust Co., St. Louis, Mo., transfer agent for the company, and register, so that the exchange may be put through.

Canadians Interested in Zinc and Lead

High Prices Induce Further Investigation of Deposits and Reopening of Old Mines

Continued high prices for zinc and lead, and the activity of representatives of European smelters searching for new sources of supply, in 1925, according to the Canadian Deputy Minister of Mines, have aroused considerable interest in eastern Canada's latent possibilities for increased production.

Eastern producers of zinc and lead ores have speeded up development and increased their output; and numerous prospects, old and new, are being explored in search of commercial ore.

In Nova Scotia shaft sinking is now in progress on the Stirling zinc-lead prospect in Cape Breton, and the old Smithfield lead mine, near Truro, in Colchester County, is being put in condition for further exploration of the orebodies. In Quebec, the British Metals Corporation has made a number of improvements both in the mine and mill at Notre Dame des Anges, that have resulted in a considerably increased output; and further diamond drilling has been done on the Federal Zinc & Lead Co.'s mine in Gaspé, though actual production has not yet been undertaken. In Ontario, the Kingdon Mining, Smelting & Manufacturing Co. is preparing to further increase the output from the Galetta lead mine; the old Frontenac lead mine, near Kingston, has been pumped out and examined, as has also the old Wright mine, on Lake Timiskaming, where diamond drilling is now being carried on from the bottom of the old workings; diamond drilling is also being done in a search for zinc-lead orebodies just west of Sud-

Snowslide at Bingham, Utah

Many Killed and Injured—Property Damage, $40,000

Bingham, Utah, was visited by the worst snowslide in its history on Feb. 17. Soon after 9 a.m. an avalanche of snow, rocks, and timbers swept down Sap Gulch and buried the McDonald boarding house and other residences of the Utah-Delaware Mining Co. The toll of dead, thirty-six hours after the accident, numbered thirty-seven and from thirty to thirty-five are missing, most of whom are believed to be dead. As if the slide, which smashed buildings into matchwood and buried over seventy-five persons under tons of débris, had not piled up enough horror, those who had been fortunate to be shielded by some chance protection such as a concrete wall, a bathtub, or timber that supported the main weight of the snow and allowed the imprisoned to breathe.

All during the night, while rescuers worked under six electric searchlights hunting for the bodies of the dead and injured, other rescuers kept fire hose trained on the fires in an effort to extinguish smoldering embers. Property damage is estimated by Superintendent Wardlaw as being over $40,000.

In the entire history of operations of Bingham, extending back to 1862, the camp has never experienced a slide as damaging. The last loss sustained from a similar cause happened six years ago, when three persons were killed in a slide.

Utah-Delaware snowslide, Bingham, Utah. Looking up canyon where snow is 25 ft. deep

fire broke out, adding to the danger and difficulty of rescue, and spreading a heavy pall of smoke over the stricken Highland Boy district.

Loss of life was greatest in the McDonald boarding house, a three-story structure in which more than sixty persons, most of them miners, were trapped in their rooms. Most of these men, it is believed, were killed instantly, so great was the force of the slide, which started on the top of the ridge and raced down precipitous Sap Gulch for a distance of two miles before meeting with opposition. Fortunately, Boston No. 1 and Boston No. 2, two other boarding houses of the company, were not in the path of the avalanche. The slide had spent itself before it reached Superintendent Frank A. Wardlaw's house and other buildings of the mine, and the main road of Carr Fork.

Work was immediately suspended in the Utah-Delaware and the Utah-Apex mines, and more than 200 men started the task of removing the living and dead from the ruins. Workmen rushed to take part in what appeared a futile effort at rescue. Part of this activity was successful in saving the lives of

The avalanche came as a climax of the second heaviest snowstorm that has occurred in the history of the state. More than a foot of heavy, extremely soft snow had fallen in a twenty-four-hour period, adding to that already on the ground.

Rambler Mines Win In Tax Sale Suit

The Rambler Consolidated Mines Corporation, owner of the Rambler mine, near Keystone, Wyo., the only property in the United States that has ever shipped platinum ore in commercial quantity, won a decisive victory in the Wyoming State Supreme Court over the Electrolytic Copper Co. in litigation that had extended over a period of five years. In their deceision the justices of the supreme court hold, as District Judge Tidball held before them, that the sale of the mine to the Electrolytic company by the county commissioners on a tax deed is illegal and void.

Litigation over the question at issue involved largely a dispute regarding taxes. The owners of the mines had agreed with one board of county tax commissioners to do road work in lieu of taxes, it is said, and had done $1,800 worth of such work when a new board of county commissioners took exception to the agreement. The sale to the Electrolytic company followed as a result.

Erroneous description of the land involved in the tax sale was cited by the Rambler company in its suit to void the sale, and it was on this main point that the case rested.

Chalk Mountain Mine Produces $86,723 in 1925

Production for 1925 for the Chalk Mountain Silver-Lead Mines Co., from its mine at Chalk Mountain, 45 miles southeast from Fallon, Nev., was 1,505 tons of ore, with net smelter returns of $86,723. Average per ton content was 0.066 oz. gold, 39.64 oz. silver, and 28.6 per cent lead. Operating costs for the year were $70,045.

The mine is opened to a depth of 485 ft. by shaft, but lateral work has not yet developed the oreshoot much below the 160 level. Crosscutting has been started at various elevations below the 160, but has not yet reached the oreshoot, owing to its flat dip away from the shaft.

Iron Cap to Resume Operations After Lengthy Litigation

F. A. Woodward, the general manager of the Iron Cap Mining Co., announced recently that the mine and mill of the company, which has been shut down for several months, will be reopened within the next three weeks. A number of stopes in the mine have been idle on account of injunctions in apex litigation between the Iron Cap and the Arizona Commercial Co. Iron Cap now has title to all the disputed territory and is making preparations to work it.

White Caps to Sink Shaft to 1,325 Level

Development work on the 1,200 level of the White Caps mine, in Manhattan, Nev., has been temporarily suspended so that the miners may resume shaft sinking from that level. The incline shaft is to be sunk 150 ft., to the 1,325 level, and lateral work will then be carried on from both levels, to develop the East orebody, and to attempt to locate the faulted segment of the West orebody.

Outlook Good for Colorado Mining

Dr. M. F. Coolbaugh, president of the Colorado School of Mines, addressed the Alumni Club of the University of Michigan at its semi-monthly luncheon held at the Elks' Club, Denver, on Feb. 4. He said that it was his belief that "Colorado would see the greatest mining business this year that has been transacted in any year for the last twenty-five; that lead and zinc would be the metals most sought for."

New Evidence Presented in the Carson Case

Late in 1925, the American Smelting & Refining Co. petitioned the Federal Court of Appeals at San Francisco for permission to reopen the Carson case and to receive newly discovered evidence. This evidence was only recently discovered and apparently established a prior use of the side-feeding idea claimed by Carson in his patents. At the Dollar Bay plant of the Lake Superior Smelting Co. in northern Michigan, several reverberatory furnaces are said to have been constructed with side-feeding hoppers in the spring and summer of 1903. Each furnace, it is stated, was provided with round iron hoppers supported above the roof and connected by chutes or troughs with not fewer than ten charge holes through the roof near the vertical side walls of the furnace. The material in the hoppers was smelting ore, and it passed into the furnace by gravity, forming sloping embankments resting on the floor of the furnace and against the side walls of the furnace. Affidavits of Henry D. Conant, assistant superintendent of the plant from May 18, 1898, and superintendent from March 15, 1915 on, were presented to the Court of Appeals along with affidavits of many workers and assistants of the plant. Apparently this use of side feeding escaped mention in technical literature and was not known outside of the plant itself.

The motion made by the A. S. & R. Co. is under consideration by the court In addition, another motion was made by the A. S. & R. Co. on the ground that the Carson suit was presented in the name of the wrong party. In opposition to this motion the plaintiff's attorneys made a motion to substitute the Carson Investment Co. in place of Carson's name. Carson's patents have been assigned to the Carson Investment Co., a new corporation under Nevada laws established July 8, 1925. This motion is also under consideration.

Carson's attorneys contend that the Dollar Bay installation was not an anticipation of their client's patents.

West End Consolidated Opens New Orebody

The West End Consolidated Mining Co. has made a new ore discovery in ground, which it is operating under lease agreement, in the southwest part of the Tonopah district, in Nevada, in the "76" vein. The discovery was made in an east drift on the 800 and is 700 ft. from the property line of any other company, thereby allowing ample territory for development without apex difficulties to hamper operations. To date the drift has been advanced 25 ft. in ore with a width of over 7 ft., which is above milling grade. It is in virgin territory more than 4,000 ft. south and west from the Ohio shaft of the West End, so that opportunities for development are practically unlimited. The vein has a strike slightly south of east, and a north dip. Metal content is typical Tonopah ratio, or 100 oz. of silver to 1 oz. of gold.

Leadfield, Calif., Claims Sold

"Some people have all the good luck" is what the friends of Fred C. Ninnis, superintendent of the West End mill, in Tonopah, are saying. A sale of a group of mining claims in the new Leadfield district, just over the California line, in which Mr. Ninnis held a one-fourth interest and didn't know it until the purchase offer was made, netted him $7,500. Frank Metts, a first-class mili man, has been working off and on for the last fifteen years at the West End mill, under Mr. Ninnis. They became close personal friends, as a good man and a good boss will, and when Metts, who had been a prospector and claim locator during the fifteen years, located several groups of claims in what is now the Leadfield district, he cut Ninnis in for a one-fourth interest in one group.

Metts sold one group for $50,000, and later was offered $30,000 for the group in which Mr. Ninnis was interested. The price being satisfactory to all concerned, the deal was made, each of the four owners received $7,500, and another instance of unsolicited and unexpected reward for the "do unto others" spirit was recorded.

Discovery of Gypsum Deposit in Ontario

A large deposit of gypsum has been discovered 140 miles north of Cochrane, in northern Ontario. Samples indicate that it is of exceptionally high quality. A large Montreal firm has urged the Ontario government to extend the Temiskaming & Northern Ontario Railway for 70 miles to reach the deposit, and offering, if this is done, to contract for from 2,000 to 20,000 tons of gypsum daily, giving substantial guarantees for fulfilment of the agreement. The firm states that there is practically no limit to the quantity of the rock they could use.

Engels Copper Reports Prosperous Year

Engels Copper Mining Co., in a preliminary report recently issued, records an operating income of $1,553,287 in 1925; operating expense was $1,032,873, leaving an operating surplus of $320,-414, which was increased by other sources of income to $559,165. Cost of concentrate on cars averaged 6.80c.; freight to smelter, 1.46c. and smelter charges 3.34c., making a total of 11.60c. per pound of copper. Gold and silver credit was 1.015c. per pound, leaving net cost of producing copper at 10.58c. per pound.

Utah-Delaware snowslide, Bingham, Utah. McDonald boarding house where many lives were lost. See opposite page

Quincy Mine Installs Electric Equipment and Reduces Costs

The Quincy mine, in the Michigan copper district, which recently cut a copper vein in the 86th or bottom level of No. 2 shaft, and has tapped the lode in No. 6 shaft. The vein is part of the Pewabic bed series in which Quincy is operating.

An electric bell and light signal system, similar to the one in use in No. 2 shaft, has been installed in No. 6, replacing the pull-bell signal system. The new arrangement has proved a complete success, operating much faster and increasing the hoisting capacity between one and two hours a day. With the installation of two powerful electric pumps in No. 6, the number of hours devoted to the hoisting of copper rock also will be materially increased, through elimination of bailing. This increase in hoisting capacity will serve to modify greatly the depths of the shafts and effect a notable saving. The pumps will drain the entire mine.

Through increased drilling efficiency and the use of mechanical loaders perfected to meet the particular needs of the mine, Quincy has made marked strides in the past year in lowering cost of opening work.

Dutch Guiana Bauxite During 1925

Exports of bauxite from Dutch Guiana in 1925 amounted to 85,525 metric tons and had a declared value of $256,157. This is a decided increase over the record for 1924, when about 55,000 tons was exported. The principal exporting company is the Surinaamsche Bauxite Maatschappij, a subsidiary of the Aluminum Company of America, and the ore exported was sent to the United States.

Early in the year, surveys were started by engineers of the above-named company to determine the amount of hydro-electric power that could be developed on the Marowyne River. Several parties were kept in the field all summer, and the results of their work must have been encouraging, as the Governor, Baron von Heemstra, and Owen de Munnick, general manager of the company, met the Governor of French Guiana at Albina and St. Laurent early in September to discuss the utilization of the river, which is the boundary between the two colonies.

By virtue of the treaty of Sept. 15, 1915, between the Dutch and French governments, no works may be constructed on the river that would interfere with hydrographic conditions except by mutual consent. It is understood that a complete agreement was reached by the two governors, and their co-operation is expected.

According to reports, a site on the river about 100 miles south of Albina has been selected, where it is estimated 200,000 hp. can be developed. The power will be utilized in a reduction plant at or near Albina.

Mining in British Guiana, 1925

The three mining industries of British Guiana, gold, diamond, and bauxite, according to the export figures just received, show an increase in 1925 over the figures for preceding year. Exports of gold amounted to 6,974 oz., against 5,491 oz. in 1924. These figures are somewhat smaller than the production figures, which will be published later by the Department of Lands and Mines, as an appreciable quantity of raw gold is absorbed in the colony in the manufacture of native jewelry.

Exports of diamonds reached 188,208 carats, valued at $4,057,285, against 184,572 carats, valued at $4,097,437, for 1924, an increase in quantity but a decrease in declared value. Two events marked the closing weeks of the year: the first flight of a seaplane from Georgetown to Kamakusa, the chief government station in the diamond fields, and the loss of the boat "Navágator" and seven of her crew in the Kataurie Falls.

Exports of bauxite for the year amounted to 174,999 long tons, against 154,324 tons in 1924. It was all exported by the Demerara Bauxite Co., Ltd., and practically all of it came to the United States. During 1925 a British syndicate examined the remaining crown lands known to contain bauxite, and it is quite certain that the Colonial Office will grant them such concessions as they believe are workable.

Guanajuato Mining Notes

Angustias, Dolores y Anexac Company is sinking an interior inclined shaft below the 300-meter level in the La Joya mine of the Cinco Señores group. This shaft is in the low-grade ore in search of a continuation of profitable oreshoots that have been productive above this level. Fifty meters at least will be sunk under the guidance of Jerome Hilbert, manager of the company. M. E. Miningham is putting up headframe and installing hoists and boiler plants at the Reforma shaft of the Santa Brigida group preparatory to lowering the water. Profitable ore has been found recently at water level in the Reforma vein but its exploitation has been difficult on account of water. Jose Maria Fernandez, who has leased and is operating the Constancia El Dorado mine, is delivering more than a hundred tons every week to Angustias mill.

It is a matter of general knowledge than the Peñoles company has taken a long-term lease on the mines of the Aurora y Anexas at Xiclin.

At the stockholders' meeting of the Aurora y Anexas, S. A., held on Jan. 25, in Mexico City, the conditions of the contract made by the directors of the company with Peñoles were made known. The Aurora company receives 10 per cent of the products of ore treated in the plant at the mine and 15 per cent of the ore sent to the Peñoles smelter at Torreon. The contract is for twenty years, but the Peñoles company may rescind it in case there is an extraordinary drop in the price of metals or other causes which makes it impossible to continue work The Peñoles company is to make improvements in the mill and to build a road for the transport of ores. A new board of directors was elected by the Aurora company, among whom are Sr. Jose G. Caso, former president of the Aurora company, and Dr. Ignacio Bonillas, geologist.

These mines have a large tonnage of fair-grade ore, but operations have been hampered by the complex nature of the ore and the distance from a smelter, the 75 kilometer haul to rail being an exceedingly difficult mountain trail. The initiation of operations by the Peñoles company in this region is expected to bring a renaissance of the mining industry there.

Big Missouri Strikes Good Ore and Plans 250-Ton Mill

The Big Missouri Mining Co., which was organized in Tacoma recently, to take over and operate the Big Missouri mine, at the head of Salmon River valley, in the Portland Canal mining division of British Columbia, has driven a crosscut through a 38-ft. body of high-grade ore.

The company's plans for the season include the erection of a 250-ton mill and some form—yet to be determined—of transportation between the mine and tidewater, at Stewart. There is little doubt that there are some large deposits of ore on the property. The transportation problem has been the chief hindrance to operation.

Keystone mine and mill, Park City, Utah
Left to right: Ore bins, office, mill and bunk house

Keystone Mining Co. Declares Dividend

Directors of the Keystone Mining Co., Park City, Utah, have declared a dividend of seven and a half cents a share, or $67,500, payable on Feb. 27 to stock of record on Feb. 17. The first dividend of the company, which is operating at Park City, Utah, was paid last August.

See Five Years' Assured Ore Supply in Colorado

Charles W. Henderson, of the U. S. Bureau of Mines office, at Denver, Colo., addressed the Colorado Scientific Society on Feb. 6 on "Probable Ore Reserves in Colorado." He estimated these at 10,000,000 tons, a five-year supply at the present rate of consumption. Mr. Henderson said:

"Probable ore is the kind that is likely to be mined eventually, but is not blocked out. At the end of the present year a much clearer prophecy can be made. Genuine data can be had only by development.

"A saving of 50 per cent in the costs of mining has been effected in the regions of Butte, Montana, at which place the skill of the geologist has been brought to the aid of the mining industry. Utah and Arizona, either of which states produces several times as much metal as Colorado, have succeeded in employing geologists in getting mining data, and the Colorado metal mining fund has made it possible to apply expert geology to mining in Colorado."

London Letter

By W. A. Doman

Special Correspondent

Rich Gold Discoveries Reported in Panama

Mystery and Vagueness Surround Financing and Exploitation of Mines

London, Feb. 9—Considerable interest is being taken in England over reported rich gold finds in Panama. Nothing of a definite nature is known, but it is reported that a prospectus is in preparation and curiosity will soon be set at rest. The first company to be formed is to be a parent undertaking, and is to have a capital of £2,000,000. All this, it is said, is underwritten, and, further, rumor has it that there was a scramble for underwriting. Important personages in the financial world are mentioned as behind the undertaking. One is said to be a former oil magnate; another is a noted politician connected with a mining company in Canada, and a third is said to be Solly Joel, of the Johannesburg Consolidated Investment Co.

The curious (connected with mining) have been searching records for gold production in Panama and confess themselves at fault. To be candid, they are sceptical, and when told that the capital of the parent company is to be £2,000,000 they make the remark that there is evidently "some financing." They can scarcely believe the report that several subsidiary companies are to be formed, and they put the very natural question, "Where are the engineers' reports?" That the Panama Mines is an actuality, however, would seem clear from the statement that a draft prospectus is in existence. Although no names of mining engineers have been mentioned, there are rumors of high assay values, not only of gold—from 5 oz. to 45 oz. to the ton—but also of silver, lead, and zinc, a sample of the first named going $5,000 to the ton. The concession, it appears, embraces many thousands of square miles. From what can be gathered from the very vague reports these gold fields are in somewhat remote places, and have not been worked for centuries. No one has ever got below water level, and no pumps have ever been seen in the country. In reality it is the vagueness of the situation with respect to the company that is exciting such great interest. Gold discoveries of recent years have been few, and a new find is bound to attract attention. Joseph Kitchin, a director of the Union Corporation, and perhaps the greatest authority on gold—I note that he is to be invited to give evidence on gold before the Indian Currency Commission—has no information concerning the reported Panama deposits. This does not imply, of course, that they do not exist, but if his researches have failed to discover particulars, it is to be inferred that the old workings now brought to light must have lain neglected for a long time. One point that people here fail to understand is that nothing has filtered through concerning Panama gold, though the examination of the area is said to have been in progress for two years. Capital, it is reported, is to be raised in London and New York, one of the biggest financial houses in the latter city taking a leading part.

From the latest cabled news received from the general manager of the Burma Corporation it would appear that an examination of the workings affected by the fire shows certain cavings, and at one point there is evidence that the fire is still smouldering. Barricades are again being erected to prevent access of air, and water is being diverted to the affected area from the level above.

Report of T.C.L. Platinum, South Africa

The latest T.C.L. platinum prospecting report, from Onverwacht, was published on Jan. 12. The average value of the dunite from 240 to 250 ft. depth was 198.7 dwt. per ton. At the 250 level, crosscuts have been driven to the north, south, east, and west. Six feet to the north averaged 10.9 dwt. Six feet to the south averaged 9.1 dwt. Fifteen feet to the east averaged 97.4 dwt. platinoids per ton, assays varying from 1.2 dwt. to 389 dwt. per ton.

Work at Burma Corporation, Ltd., Proceeds Normally

Burma Corporation, Ltd., reports that during January, 1926, 34,974 tons of ore was mined, and 27,000 tons of ore was milled, at its properties in Upper Burma, producing 11,504 tons of lead concentrates. The smelter handled 11,832 tons of lead-bearing material, producing 4,983 tons of hard lead for treatment in the refinery. Refinery products were 4,700 tons of refined lead and 488,800 oz. of refined silver. The experimental zinc plant produced 3,120 tons of zinc concentrates, assaying 13.4 oz. silver, 7.9 per cent lead, and 45.5 per cent zinc.

In addition to the above-recorded production, 850 tons of copper matte was produced from the treatment of accumulated smelter byproducts and 4,178 tons of copper ore. Work is proceeding normally, and no interference from accumulation of gases is expected for the present. Whether the accumulation will interfere as gas pressure develops depends upon the degree of isolation effected by the caved ground north and south of the area.

Welsh Tin-Plate Makers Form Selling Pool

Tin-plate makers of Wales have entered into an agreement, effective Feb. 8, to pool all orders, according to consular advices to the U. S. Department of Commerce. Each member of the pool, which is composed of 95 per cent of the trade, has a quota allotment of orders. He may exceed this quota and may sell at such price as he will, but for every box of tin plate that he sells over his quota he must turn over to the pool 1s., of which the members selling less than their quota in the same period receive 9d.

Johannesburg Letter

By John Watson

Special Correspondent

Platinum Continues to Be Topic of Interest in Technical and Financial Circles

Johannesburg, Jan. 19.—At the meeting of the Chemical, Metallurgical, and Mining Society of South Africa, held in Johannesburg on Jan. 16, an interesting lecture on "The Bushveld Igneous Complex," was given by Dr. A. L. Hall, of the Union Geological Survey. The lecturer dealt with the occurrence of platinum on the line of the Merensky reef, describing the platiniferous minerals. His discussion was illustrated by a large number of beautiful photoslides, by geological maps, sections, and mineral specimens.

Dr. Merensky is leaving soon for Europe, in connection with developments of the platinum industry. Interviewed recently by a correspondent, Dr. Merensky said that he has received many cable dispatches from various Continental firms which are asking if South Africa can really supply them with large amounts of platinum for many years to come. He hopes to be able to give them trustworthy data on that point, as he is still optimistic with regard to the future of the platinum industry here. About eighteen tons of platinum-bearing ore has recently been sent to Germany, and Dr. Merensky is going to make a careful personal investigation of the methods for the recovery of platinum. By oil-flotation, an extraction of 94 per cent, on a working scale, has already been obtained. Electro-amalgamation he thought very promising, as by that method the platinum is recovered direct in metallic form.

Inspector C. J. N. Jourdan, of the Union Department of Mines, was in charge of the South African Mineral Exhibits at Wembley; he then investigated potential markets for South African minerals in Europe, and has returned, with great hopes for the future of such base minerals as asbestos, chrome, corundum, mica, talc, and kaolin. He thinks there is a prospect for Lydenburg chrome; but competition is keen, as Rhodesia and Baluchistan are already supplying excellent chrome ore.

The Messina Development Co. is the only copper producer in the Transvaal; for the last year, the company's total dividend has been brought up to 20 per cent. This is the first distribution since the middle period of the Great War, when copper was abnormally dear. Ore reserves are three years ahead of the mill.

On the Johannesburg Stock Exchange, during the past week, there has been substantial local buying of several of the leading gold-mining shares for investment. T. C. Land shares were sold by local operators, and London was also buying. Their price fell, up to Friday, but recovered on Saturday. Transvaal Platinums rose from 29s. to 37s. during the week.

Societies, Addresses, and Reports

Milling and Concentration at the Institute Meeting

Filtration, Classification and Crushing Topics Discussed at Well-Attended Session

Ore dressing was the subject of a well-attended meeting on Monday, Feb. 15, at the recent annual meeting of the A.I.M.E., in New York. G. H. Clevinger presided.

Lincoln T. Work presented a paper writen by himself, Arthur W. Hixson, and Isaac H. Odell, Jr., on the "Mechanism of Filtration." The generally accepted theory of good filtration demands that the openings in the medium should be larger than the largest solid particles in the pulp and that a thin layer of coarser particles "bridging" the openings should be formed at the beginning of a cake-forming operation. The principle conclusion reached in the paper, aside from the desirability of having the pulp as thick as can be handled conveniently, is that it may prove profitable to introduce a coarse "filter aid" in a pulp containing particles too fine to form the proper bridge on a filter medium with openings of practicable size. In discussing the paper G. H. Clevinger, remarked the great progress made in filtration. Ten years ago the importance of thick pulps was not realized; and high pressures were the measure used to hasten filtration. J. M. Callow told of the success of the Genter "filter-thickener" at Trail, where equipment totaling 9,000 sq.ft. is used for dewatering concentrates and sludge in the electrolytic zinc plant, preliminary to final dewatering with filters of the vacuum type.

IMPORTANCE OF CLASSIFICATION

Bennett R. Bates, who has returned recently to the United States after spending eighteen months in South Africa, emphasized in his paper on "Classification on the Witwatersrand" the need for removing an adequate proportion of the material reduced to the desired fineness in the classifier, so as to obtain efficient grinding in the tube mill. The circulating load must be cut down. In the discussion that followed, the point was made that sand might be cleaned so thoroughly that the grinding efficiency would be decreased as a consequence of lack of viscosity in the pulp. A. F. Taggart drew a distinction between density and viscosity. One engineer was inclined to think that the admixture of slime to increase viscosity was not necessary if the moisture content of the pulp was controlled closely. He had found in one series of experiments on cleaned sands of various sizes a critical density above or below which results became less efficient. Mr. Bates told how the extraction at the McIntyre mill, at Porcupine, had been increased remarkably by concentration of the gold-bearing pyrite in a Dorr classifier, so as to get additional grinding.

A. M. Gaudin's paper, entitled "An Investigation of Crushing Phenomenon," brought out the difference in the behavior of homogeneous and heterogeneous rock in crushing and grinding. A "straight-line" relation holds good in the reduction of a homogeneous rock down to 325 mesh, whereas with a non-homogeneous rock the "grain size" spoils this relation. The paper analyses the work done by jaw crushers, rolls, ball mills, and rod mills. It suggests the advantages of more careful study of this operation on the part of the millman. The need for efficient sizing below 200 mesh was emphasized, Prof. J. W. Porter, of McGill, concurring strongly in this view. An interesting side light brought out in the discussion of rolls was the experimental work being done by a large manufacturer of crushing machinery, looking to the substitution of hydraulic resistance for the spring in the standard design of crushing rolls.

U. S. Chamber of Commerce Favors Contract System

The growing tendency of public officials to expend public funds for construction work by the day labor rather than by the contract system is denounced by a special committee of the Chamber of Commerce of the United States in a report made public on Jan. 28. The report is submitted by Joseph H. Defrees, of Chicago; Arthur S. Bent, of Los Angeles; John M. Crawford, of Parkersburg, W. Va.; Clyde C. Dawson, of Denver; and Sylvester L. Weaver, of Los Angeles. It will be considered by the national body at its annual meeting in May.

Of approximately $2,000,000,000 expended annually for public construction, the committee estimates that $300,000,000 is expended by public officials themselves by the day-labor method.

"The day-labor method in public construction," the committee asserts, "means that public officials not chosen for office because of their training and success as construction managers assume charge of great projects without furnishing any guarantee to the paying public of either cost, quality, or time of completion."

New Jersey Zinc Co. Endows Research Fellowships

A research fellowship in science and technology at Lehigh University, Bethlehem, Pa., has been established by the New Jersey Zinc Co. Appointment to this fellowship will be for the period of two academic years beginning Sept. 1, 1926, with an annual stipend of $600, payable in ten monthly installments, and freedom from university dues, except the matriculation fee of $5 and the graduation fee of $10. Half of the time of the holder of this fellowship must be devoted to research work in the field of science or technology to which he is assigned; the other half to graduate study leading to the degree of master of science at the end of the two-year appointment, provided all university requirements have been satisfied.

Michigan College of Mines Begins Iron and Copper Research

High-sulphur ores are receiving the immediate attention of a group of seniors at the Michigan College of Mines, at Houghton, Mich., who are working in accordance with a plan outlined by Prof. A. T. Sweet, head of the metallurgy and ore-dressing department. This is in keeping with the program of the Iron Committee, which met at the college recently and advised that the problem of removing sulphur from iron ore be the first undertaken. Work at present consists of determining the physical and chemical properties of the ore and methods for the removal of sulphur.

Copper research has been going on for some time, and the college metallurgists and ore dressers are only awaiting the meeting of the Copper Committee to organize and suggest future work. Many of the problems suggested will require considerable time for their solution and perhaps more equipment. One large tilting oil-fired furnace, to be used to melt large batches of copper for the purpose of experimentation, has been added to the metallurgical equipment at the college. It will prove invaluable in the study of the effects of various impurities on the physical properties of the metal.

One six-cell electro-deposition unit, which will be used in copper research work, also has been received. This unit is of the latest type.

Southern Division of A. M. C. Will Meet in Memphis

An Industral Development Conference will be held at Memphis, Tenn., March 15 to 17, under the auspices of the Southern Division of the American Mining Congress. Arrangements are being made by William H. Lindsey, of the Napier Iron Works, of Nashville, chairman of the Southern Division, and Henry Mace Payne, consulting engineer to the American Mining Congress and acting secretary of the Southern Division.

The conference is expected to be the largest industrial gathering of its kind ever held in the South. Among the subjects which will be discussed by leaders of national prominence in their respective fields are: opportunities in the South for mineral development; Southern mineral tariffs; neglected issues in labor relations; power in industry; public versus private operation of industries; epidemic of legislation; development of branch-line transportation; freight rates to new mining centers; developments in electric smelting; financing industrial developments; retarding mineral development by erratic taxation; and the severance tax and its various applications.

Petroleum Geologists to Meet in Texas

The eleventh annual convention of the American Association of Petroleum Geologists will be held in Dallas, Texas, March 25, 26, 27, according to an announcement made by R. E. Rettger, of the entertainment committee. Headquarters will be at the Baker Hotel.

Consolidated Lead & Zinc an Important Factor in Joplin District

The Consolidated Lead & Zinc Co., which became an important factor in the Joplin-Miami field recently by virtue of a merger of several properties, including that of the Underwriters Land Co., has further enlarged its holdings by closing options which it held on the Tulsa-Quapaw Mining & Investment Co.'s mine, the Tulsa-Quapaw royalty interests, and the Baby Jim mine, all in the Oklahoma section of the district. It is unofficially reported that approximately $700,000 was the consideration paid for the three properties.

Options on the Domado and Jack & Jill mines, also held by the Consolidated, were allowed to lapse, though it is rumored that negotiations looking toward their acquisition have been reopened. The Tulsa-Quapaw mine has been one of the big producers of the field, its output being approximately 4,000 tons of zinc and 1,200 tons of lead concentrates during 1925. The Baby Jim produced approximately 3,500 tons of zinc and 500 tons of lead concentrates during 1925.

Tulsa-Quapaw royalty interests include a first lease on 200 acres of the Staten land, in the Cardin, Okla., section, whereon are located some of the good mines of the district, including the Rialto, L. & G., Baby Jim, and Domado. With its latest acquisition, the Consolidated company now has eleven active mines in the district and is conceded a place among the five largest producing concerns.

F. N. Bendelari, of Joplin, formerly president of the Underwriters Land Co., has been elected president of the Consolidated Lead & Zinc Co., and T. C. Curry, who was president of the old Consolidated, secretary and treasurer. Stock of the company has been listed on the St. Louis Stock Exchange.

Airplane Service to Red Lake District, Ont.

A commercial air service to the Red Lake mining camp, in the Patrica district of northern Ontario, will be established as soon as possible by John G. Elliott, of Hamilton, Ont. Three airplanes will be placed in operation, which will carry passengers and freight from Hudson, on the Transcontinental line of the Canadian National Railways, to the mining area. Arrrangements are being made with the Ottawa Postal Department under which the planes may conduct a special mail service. The enterprise is purely a personal one, and necessitates no government aid.

McDougall-Cassell Property, Rouyn Area, Quebec, Sold

A syndicate including several officials of the McIntyre-Porcupine company and H. A. Guess, of the American Smelting & Refining Co., has secured the McDougall-Cassell property adjoining Amulet, in the Rouyn area. A diamond-drilling campaign will be started at once with the object of encountering lenses of ore.

Golden Rod Enlarges Holdings in Joplin-Miami

Golden Rod Mining & Smelting Co. has purchased a controlling interest in the Black Hawk Lead & Zinc Co.'s mine, located in the south part of Picher, Okla., in the Joplin-Miami district. It also has purchased the Black Hawk company's interest in the Monarch and East Side mines, in the Kansas section of the field. Edgar Z. Wallower, Jr., president of the Golden Rod company, announced the purchase and stated that W. L. Kepner, who has been managing the Black Hawk mine for the last three years, will continue in that capacity. The Golden Rod company recently obtained a lease on 200 acres of the Weiss land, south of Hockerville, has been carrying on an intensive drilling campaign, and will start shaft sinking in the near future.

Bureau of Mines Car at Tonopah

U. S. BUREAU of mines Car No. 1, with K. S. Butler in charge, arrived at Tonopah, Nev., on Feb. 15, and will remain in this district for about three weeks. Mining camps off the railroad will be visited by Butler, and instruction in mine rescue and first aid will be given wherever practicable.

British Columbia Mines Yield $66,526,074 in 1925

British Columbia's mine products in 1925 are estimated at $66,526,074, an advance of almost $18,000,000 over the 1924 value of $48,704,604, which was an advance of $6,000,000 over the record for 1923, states the British Columbia Department of Commerce.

Lead, the largest item as to value in both 1924 and 1925, rose from $12,415,917 in the former year to $21,311,522 in the latter, and an increase was noted in all the items recorded. The increased production of minerals in 1925 was due chiefly to advances in market prices, the larger output in silver and zinc being most conspicuous. The increasing world demand for zinc and lead has not only improved prices and augmented production, but has resulted in the expenditures of large sums in the improvement of milling and smelter facilities.

It is estimated that between $95,000,000 and $100,000,000 is invested in the mining industry in the province.

Goudreau Area, Ontario, Attracts Many Prospectors

The Goudreau mining area of northern Ontario has been attracting many prospectors, and nearly 200 claims have been staked during the winter.

The Pioneer Syndicate has arranged for the transportation of eighty tons of machinery to the Minto and Cooper properties, at Wawa, where operations will begin immediately. A special railway service has been arranged for over the Hawk Junction branch of the Algoma Central Railway, which is not at present in operation.

Arizona University to Give Special Course in Mine Administration

Dean G. M. Butler of Arizona University has announced that a special course in mine administration, limited to twelve graduate mining students who have had several years of practical experience and who are recommended for the course, will be given by the mining college of the university next fall under the direction of E. P. Mathewson, consulting metallurgist. The course will consist of a month on the campus, during which a course of lectures will be given, and a month of actual work in the mining camps of the state. The aim will be to train capable administrators and executives. Further details will be announced later.

Indiana Mine, Okla., Sold for $100,000—Other Options Pending

George W. Potter, vice-president of the Eagle-Picher Lead Co., and T. C. Curry, secretary-treasurer of the Consolidated Lead & Zinc Co., have contracted for the purchase of the Indiana Mining Co.'s mine and lease, located between St. Louis, Okla., and Hockerville, for a consideration of $100,000. They also have taken a drilling option on the Martha B. mine and 80-acre lease, located south of Baxter Springs, Kan., and will pay $50,000 for this property if drilling results encourage them to close the option. The sellers are R. N. Jensen, of Baxter Springs, who owned a majority interest in the Indiana, and John White and associates, who were interested with Jensen in the Martha B.

Dr. A. G. Hull, owner of the Rialto mine, is reported to have paid $80,000 for the fee on which the Toltec mine is located, near Hockerville, Okla.

Noranda Issues Progress Report

Directors of the Noranda mine, in northwestern Quebec, have issued a progress report dealing principally with new developments on the third level. On the B orebody 100 ft. has been driven, giving average assays of $4 in gold and 4½ per cent copper, and 25 ft. of crosscut gave an average of $36.30 in gold and 4.69 per cent copper. A horizontal bore hole driven into the E orebody on the third level showed 120 ft. of ore averaging $1.39 in gold and 4.12 per cent copper. A crosscut in the H orebody, which on the 100- and 200-ft. levels has been low grade, gave an average of $3.20 in gold and 2.4 per cent copper over a width of 35 ft. Five orebodies have been encountered on the third level, and more ore is indicated on this level than on the second. This, however, may be due to lack of development on the second level. None of these developments on the third level have been considered in any estimate of ore reserves. The company is taking large quantities of supplies in over the snow during the winter, so as to begin the erection of a smelter at an early date. The railway company advises that 35 miles of right-of-way has been cut, 11 miles of grading finished, and that more than 700 men are at work on the line.

Recent Technical Publications

Reviews, Abstracts, and References

Manganese — "Manganese and Manganiferous Ores in 1924," 14 pages, by Helena M. Meyer, has recently been issued by the U. S. Bureau of Mines in the "Mineral Resources" series. The change in the method of reporting imports of manganese ore, which have been given in terms of manganese content since Sept. 22, 1922, instead of in terms of gross weight as before, is mentioned. This has caused a great many errors in recording and interpreting statistics. The bulletin appears too late to be of much more than historical interest. It may be obtained for 5c. from the Superintendent of Documents, Washington, D. C.

Australian Reports—The official year book of the Commonwealth of Australia, for 1925, 1,110 pages, is now obtainable on request from The Official Secretary, Office of the Commissioner for Australia, 44 Whitehall St., New York City. The book contains a vast amount of information and data regarding all of Australia's industries and welfare.

The report of the Western Australian Department of Mines, for 1924, has also recently been received, and may be obtained from the Department of Mines, Perth, Western Australia.

Chemical Engineering — Part 1 of Vol. XVI of the *Transactions* of the American Institute of Chemical Engineers, recently published by D. Van Nostrand Co., New York City, contains the following papers of interest to some mining engineers: "Some Factors and Principles Involved in the Separation and Collection of Dust, Mist, and Fume From Gases," 18 pages, by Evald Anderson; "Refined Sulphurs; Their Manufacture and Uses," 22 pages, by Charles A. Newhall; "Progress in the Application of Continuous Hydrometallurgical Methods in the Chemical Industry," 18 pages, by John V. N. Dorr; and "Treatment of Industrial Wastes to Prevent Stream Pollution," eight pages, by Frank Bachmann and E. B. Besselievre.

Bureau of Standards—The publications of the U. S. Bureau of Standards, covering the period 1901-1925, are catalogued and briefly described in Circular No. 24 of the Bureau, recently issued. Copies are obtainable on request to the U. S. Bureau of Standards, Washington, D. C.

Gold Coast—The report of the Mines Department, Government of the Gold Coast, for the period April, 1924, to March, 1925, is now available at 2s. from the Crown Agents for the Colonies, 4, Millbank, London, S. W. 1, England. The principal mining industries of the colony are gold, manganese, and diamonds.

Canadian Mining—The report of the Department of Mines for the fiscal year ending March 31, 1925, is now available for 15c. from the Department of Mines, Ottawa, Ont. It summarizes in brief form the activities of the various branches of the department and includes a list of recent publications.

Gas Analysis—U. S. Bureau of Mines Bulletin No. 42 has been brought up to date and has been reissued as Bulletin 197, entitled "Sampling and Examination of Mine Gases and Natural Gas." It consists of 108 pages. The original authors are George A. Burrell and Frank M. Seibert, the revision having been made by G. W. Jones, who has brought the laboratory methods up to date and has omitted description of some types of apparatus that are now obsolete. The bulletin is obtainable for 25c. from the Superintendent of Documents, Washington, D. C.

Aluminum Prices—Robert J. Anderson contributes an article to *The Mining Journal* (London; price 8d.), the first installment of which appears in the Jan. 30 issue, on "The High Price of Aluminum." Mr. Anderson gives a rather thorough study of the situation, on which editorial comment is made.

Patents

Zinc Smelting—No. 1,573,013. Feb. 16, 1926. W. A. Ogg, Newton, Mass. Using a retort furnace and condenser, the retort is charged with a sufficient amount of ore and reducing fuel so that a volume of metal vapor is produced in substantial excess of the capacity of the condenser fully to condense. The excess vapor from the condenser is separately treated.

No. 1,573,014. Feb. 16, 1926. W. A. Ogg, Newton, Mass. A chloride is added to the retort charge, a part of the metal vapor caught in a condenser, and the remaining fume precipitated and leached. The wash water is mixed with fresh crude material and fuel, and the whole then briquetted to form a charge for a subsequent volatilizing operation. Patent No. 1,573,015 issued to the same applicant is similar except that a fluxing haloid is specified instead of a chloride.

Mining Sulphur—No. 1,573,026. Feb. 16, 1926. W. C. Averill, Jr., Houston, Tex. The sulphur-bearing stratum is penetrated by a drill and sand is caused to flow from an intermediate stratum to fill the channels and cavities in the sulphur deposit and retard the escape of hot water from the vicinity of the well.

Grinding Mill — No. 1,573,032. Feb. 16, 1926. W. N. Beyerle, Mesa, Ariz. A grinding mill of the type in which large balls roll around in an annular trough.

Aluminum—No. 1,572,253. Feb. 9, 1926. D. H. Tilson, Badin, N. C., assignor to Aluminum Co. of America, Pittsburgh, Pa. A method for starting electrolytic cells containing molten material.

Rotary Drier—Reissue No. 16,265. Feb. 16, 1926. W. A. Harty, Buffalo, N. Y., and F. W. Moore, Thorold, Ont. A rotary drier with a screen at the discharge end and a central heating tube extending through the shell and screen, rotating therewith. A burner at the end projects a flame into the tube.

Drilling Equipment — No. 1,571,993. Feb. 9, 1926. L. C. Bayles, Easton, Pa., assignor to Ingersoll-Rand Co., Jersey City, N. J. A valve for rock drills.

No. 1,572,048. Feb. 9, 1926. E. F. Spencer and C. O. Spencer, Commerce, Okla. Design for a drill-pulling jack.

No. 1,572,529. Feb. 9, 1926. H. V. Haight, Sherbrooke, Que., assignor to Ingersoll-Rand Co., Jersey City, N. J. A chuck assembly for a rock drill.

No. 1,572,729. Feb. 9, 1926. F. M. Lee, Chicago, assignor to Sullivan Machinery Co. A drill-sharpening mechanism.

No. 1,573,457. Feb. 16, 1926. F. M. Slater, Easton, Pa., assignor to Ingersoll-Rand Co., Jersey City, N. J. A valve for rock drills.

No. 1,573,458. Feb. 16, 1926. W. A. Smith, Athens, Pa., assignor to Ingersoll-Rand Co., Jersey City, N. J. A cushion handle for rock drills.

No. 1,573,790. Feb. 16, 1926. J. V. Rice, Jr., Bordentown, N. J., assignor to Rice Portable Rock Drill Corporation, Wilmington, Del. A gasoline rock drill, the pulsations being effected by the explosion of gasoline vapor instead of compressed air.

Hydrometallurgy — Nos. 1,572,114-5. Feb. 9, 1926. W. E. Greenawalt, Denver, Colo. These patents cover a complete system for the acid leaching of copper ores, removal of impurities, and electrolytic precipitation. Sulphur dioxide is used as a reducing agent. Flow sheets are given.

No. 1,572,268. Feb. 9, 1926. N. C. Christensen, Salt Lake City, Utah. Finely ground lead-zinc ores are treated with an acid concentrated brine solution which dissolves the lead and some of the zinc as chlorides, and drives off hydrogen sulphide. The gas is treated with lime to form calcium sulphhydrate, which is, in turn, used to precipitate first the lead and then the zinc, from the brine solution.

No. 1,573,233. Feb. 16, 1926. R. B. Eldridge, Denver, Colo. Inorganic impurities in zinc sulphate solutions are precipitated by the action of a soluble hydrosulphite, and the precipitate separated from the solution.

Retort Furnace—No. 1,572,291. Feb. 9, 1926. W. P. Jobson, Philadelphia, assignor to H. S. Souder, Souderton, Pa. A retort furnace with means for intermittently supplying ore thereto, for moving the ore longitudinally in the retorts, for drawing off the fumes and for washing the drawn-off fumes and precipitating the solid matter therein.

Chloridizing Leaching—No. 1,572,388. Feb. 9, 1926. Harry Hey, Melbourne, Victoria, Australia. Lead and silver are recovered from sulphide ores by subjecting the ore to heat in the presence of gaseous hydrochloric acid under non-oxidizing conditions to effect the preferential chloridizing of the lead and silver, while inhibiting the chloridization of other sulphides. The silver and lead chlorides are then leached out.

Fume Filter—No. 1,572,888. Feb. 16, 1926. Emil Danhardt, Cologne-Kalk, Germany. A cylindrical casing, with conical bottom, inside of which are filter pockets for removing dust from gas and vapors, more especially from blast-furnace gases.

Men You Should Know About

W. Spencer Hutchinson, who has recently returned from Africa, attended the New York meeting of the Institute.

J. F. Johnson, shaft contractor and mining engineer of Eureka, Utah, is in San Francisco.

Philip S. Smith, chief Alaskan geologist of the U. S. Geological Survey, and **Gerald FitzGerald** sailed from Seattle for Alaska on Feb. 13.

Lucien Eaton, mine superintendent at Ishpeming, Mich., for the Cleveland-Cliffs Iron Co., attended the meeting of the A.I.M.E. in New York last week.

B. F. Hoyt, of New York, recently visited the Michipicoten mining area of northern Ontario, where he is interested in the Mission claims.

Charles G. Ewing, of St. Louis, president of the Philipsburg Mining Co. and the American Gem Syndicate, is inspecting the Montana properties of these companies.

Louis D. Mills, consulting engineer of The Merrill Company of San Francisco, was recently in New York and is now in Canada in connection with the company's business.

H. C. Holthoff, inventor of the Holthoff furnace, has resigned from his position with the Allis-Chalmers Manufacturing Co., and has gone to Los Angeles, Calif.

Leonard J. Buck, who is now with W. H. Muller & Co. in connection with the marketing of Russian manganese ore, sailed on Feb. 20 for a six weeks' business trip in Europe.

Ralph V. Thurston has finished surveying and mapping the workings of the Mother Lode Copper Co.'s mine near Baker, Ore., and has returned to Payette, Idaho.

D. M. Reck has resigned his position as engineer with the Midland Copper Co., at Twin Buttes, Ariz., and entered the employment of the Goldtown Mining & Milling Co. at Mojave, Calif.

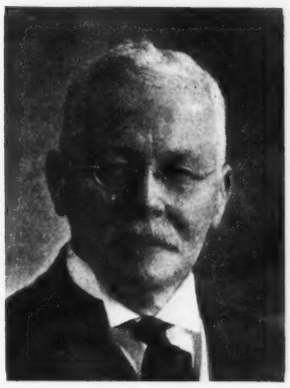
Lorne D. Howie, original discoverer of the Red Lake gold deposit in the Patricia district of northern Ontario, has returned from the property. He states that the sampling and exploration of the claim is proceeding in accordance with the comprehensive plan adopted.

Milton I. Leydig, mining engineer, formerly manager of the Ruby Gulch Mining Co. at Zortman, Mont., and the Beaver Creek Mining Co., at Philipsburg, in the same state, has been appointed general manager of the Iron Mountain Mining Co.'s property, near Superior, Mont.

W. C. Plumb, former superintendent of mines at Mammoth, Calif., has been appointed general superintendent of the Mason Valley Mines Co., in Nevada. **F. M. Merriles** has resigned from the engineering staff to accept a position with Jules Labarthe in manganese mines in the Caucasus.

J. E. Dugan, foreman of the Nettie mine of the Anaconda Copper Mining Co., at Butte, Mont., has resigned to accept a position as general manager of the California Zinc Co., in Shasta County, Calif. **William J. McClain,** foreman of the Berkeley mine, has been transferred to the Nettie mine as foreman.

George Young, for the last twenty-three years associated with the Cananea Consolidated Copper Co. in Mexico, as auditor and later as secretary-treasurer, has tendered his resignation on the grounds of ill health. **Casey Stites,** assistant auditor, will be promoted to be treasurer. No new secretary has yet been appointed.



W. E. Scott

W. E. Scott, professor of geology and paleontology at Princeton University, has been notified by the Academy of National Science that he will receive the 1926 Hayden Medal for distinguished work in investigation and research.

Walter Douglas, president of the Phelps Dodge Corporation and a director of the Southern Pacific Railroad, recently made a three-day inspection of the Copper Queen branch of the Phelps Dodge Corporation. Mr. Douglas was accompanied by **Stephen Birch,** president of the Kennecott Copper Corporation, and **David Goodrich,** of the Goodrich Rubber Co.

Stanly A. Easton, manager of the Bunker Hill & Sullivan property at Kellogg, Idaho, is in San Francisco on a short visit. A luncheon was given in honor of Mr. Easton by F. W. Bradley, at the Bohemian Club, on Feb. 17, 1926. The directors and officials of the Bunker Hill & Sullivan Mining & Concentrating Co. as well as a number of friends were present.

Edgar L. Newhouse, manager of the Salt Lake department of the American Smelting & Refining Co., has been advanced to fill an appointment in the New York office of the corporation. He will be succeeded at Salt Lake by **W. J. O'Connor,** now manager of the East Helena plant. **B. N. Rickard** at present in the ore purchasing department of the company in Utah, will succeed Mr. O'Connor at East Helena.

Howland Bancroft has been elected vice-president and general manager of the Lago Petroleum Corporation. He will make his headquarters in Maracaibo, Venezuela. Mr. Bancroft, who was formerly vice-president and managing director of the Sinclair Panama Oil Corporation, has just returned to the United States from an extended trip through Turkey in Asia. He will sail for Venezuela in the near future.

D. F. Hewitt, M. S. Goldman, and **H. C. Ferguson,** of the U. S. Geological Survey, will attend the International Geologic Congress in Madrid. The program of the congress extends from May 10 to June 12. Mr. Hewitt will leave March 12, so as to have time to visit England, Germany, Poland, Sardinia, and Greece, in addition to Spain, where he will compile data on European production of manganese, lead and zinc.

M. Stewart returned to Australia on Jan. 21 from Rabaul, after having spent nine months in New Guinea as leader of a geological survey expedition, which had been engaged in the search for oil on behalf of the Colonial Exploration and Development Syndicate. The expedition consisted of Mr. Stewart as leader, **R. J. Winters,** geologist, and two assistants, besides forty natives. The purpose of the expedition was to investigate the Vanimo area of the Aitape district, 18 miles from the Dutch border. A good deal of the country traversed had never before been penetrated by white men. Mr. Stewart said that the indications of oil that had previously been reported had exceeded his expectations. Another expedition is to be sent to Vanimo to begin boring operations.

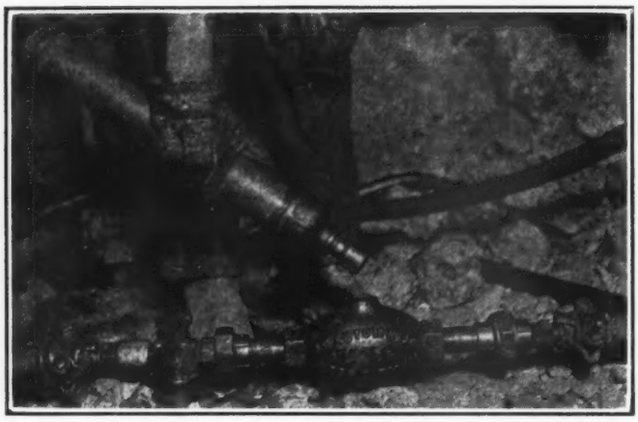
J. B. Tenney, assistant geologist of the Arizona Bureau of Mines, has been named as investigator to collect data concerning the mining industries of the state for the bureau, according to an announcement by **Dean G. M. Butler** of the University of Arizona College of Mines and Engineering. The increased mining activity in Arizona during recent years and the growing demand for information regarding the state's mineral resources, according to Dean Butler, has made necessary the creation of an office in the bureau to take care of the securing of these data. Mr. Tenney's new work will take him into all mining camps in the state and he will be expected to gather a staff of correspondents who will forward him information on last-minute activities just prior to the compilation of the bureau's annual report.

Obituary

Mathew Baroch, mining man in Colorado and Wyoming, died recently at his Denver home, aged sixty-five. He was a member of many mining societies.

Harry L. Snyder, a Colorado mining man, died recently at Hollywood, Calif. Mr. Snyder was born at Black Hawk, Colo., in 1867, his father, Louis C. Snyder, being one of the early pioneers to that mining section in 1859. He was a graduate of Notre Dame University, having received his mining engineer degree from the Indiana college.

New Machinery and Inventions



The line oiler shown here should be as close to the drill as possible. It can be used with all pneumatic tools

Line Oiler Insures Lubrication for Rock and Hammer Drills

A constant supply of lubricating oil is necessary for the up-to-date hammer drill if it is to work with maximum efficiency and minimum upkeep cost. If it were not for the human equation, the oil reservoir of the hammer drill itself would be amply large enough to supply this need, but as it is always necessary to take the human factor into consideration, the extra weight that would necessarily be added to the hammer drill to secure the increased reservoir capacity would be detrimental. For this reason, the Sullivan Machinery Co., Chicago, Ill., has designed a line oiler, which is shown in the accompanying cut, to meet this need.

This oiler, which is known as the "J-C" line oiler, consists essentially of an egg-shaped casting, of a net weight of 7 lb. and strong enough to stand the abuse of underground work, simple in principle of operation, and with an oil reservoir of sufficient capacity so that it requires only two fillings per eight-hour shift. The common method of using the oiler is to attach it with ordinary hose connections to the end of the air hose and then to use a short length of hose (8 to 10 ft.) between the oiler and the drill to be lubricated. It is possible to use lubricating oils of varying viscosity by merely changing the feed nozzle of the oiler. Experience has proved that hammer drills equipped with this oiler give better performance with less upkeep.

An arrow on the oiler indicates the direction of the flow of air through it. Part of the air is deflected into the oil reservoir, forcing the lubricant out through the nozzle into the air line. A plugged hole is provided for filling the oiler.

Blasters' Handbook Issued

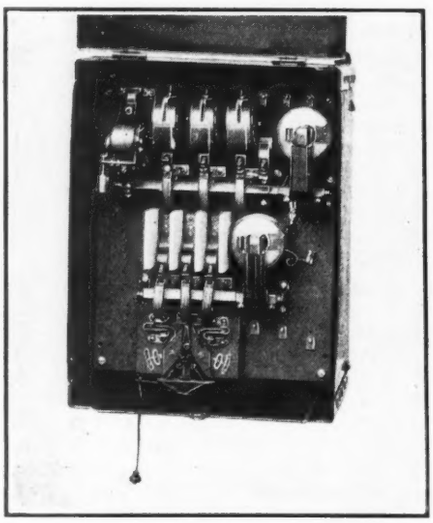
A new edition of the "Blasters' Handbook" published by the E. I. du Pont de Nemours & Co., has been issued. This book has recently been revised and enlarged so that it now comprises a brief description of du Pont explosives and blasting accessories and a full exposition of practical blasting methods in all major operations.

Improvements in Starters Increase Reliability

Primary resistance starters for squirrel cage induction motors built by the General Electric Co. and designated as CR-7056-D-1, have been superseded by two new types, the CR-7056-D-3 in sizes up to 25 hp., and the CR-7056-D-4 in capacities from 25 to 50 hp. The D-3 is provided with arc barriers and the D-4 is equipped with magnetic blowouts and arc chutes, permitting the handling of the larger motor currents. Both starters have an improved magnetic time interlock, an important change being that the operating spring is in compression instead of tension. The interlock can thus be adjusted more easily.

These resistors also have been redesigned and enlarged to give greater capacity, and conform to Classification No. 16 of the Electric Power Club, which provides 200 per cent full load current or more on the first point for 15 sec. out of every 4 min.

The inclosing case of the D-3 starter opens from the top, is ventilated, has two 1¼-in. knockouts in the top and has two knockouts of the same size in the bottom. These provide ample space for power and control wires. The cover may be padlocked shut if desired.



New Starter With Cover Raised

Gear-drive Gasoline Locomotives Announced in Four Sizes

A new line of gasoline gear-driven locomotives, ranging in size from eight to twenty tons, is announced by the Davenport Locomotive Works, Davenport, Iowa. In these, geared transmission replaces the roller-chain transmission and individual wheel drive of the present Davenport gasoline locomotives, although the manufacture of the original type will also be continued.

Many new features of design and construction have been incorporated, among which is a three-point suspension principle with cross equalizer to give improved tracking qualities. Semi-elliptic springs have been employed because of the wider distribution of stresses and better dampening of shock obtainable with this type. A fully inclosed, roomy, all-steel cab is provided for comfort and convenience in operation.

Open, accessible design has been used in these machines to facilitate quick adjustments and repair, and the construction is rugged and simple throughout. Various new mechanical features have been incorporated. The master clutch is a step jaw clutch which is always halfway in when the faces are engaged, thus eliminating the possibility of chipped corners on the clutch faces.

Both engine and transmission have individual force feed lubrication systems with pressure gauges in the cab. Alemite fittings are provided for the journals at the driving wheel.

Climax engines are used—six cylinders in the sixteen- and twenty-ton sizes and four cylinders in the eight- and twelve-ton—with four speeds forward and four reverse. Both speed and direction selection clutches slide on splined shafts for accurate, positive engagement and lock automatically in position.

Trade Catalogs

Welding Torches—Cutting and welding torches are covered in a 12-page catalog issued by the Alexander Millburn Co., of Baltimore, Md.

Flow Meters—The Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill., has issued a new bulletin entitled "Measurement of Water."

Magnets—Separator magnets are described in a four-page bulletin issued by the Electric Controller & Manufacturing Co., Cleveland, Ohio.

Shovels—A new bulletin of 32 pages, describing Bucyrus 120-B steam or electric four-yard full-revolving shovel and illustrating also, a heavy-duty mine and quarry shovel which can be equipped with 4, 3½, or 3-cu. yd. dippers, has been issued by the Bucyrus Co., South Milwaukee, Wis.

Locomotive—The Davenport Locomotive Works, Davenport, Iowa, has issued a circular carrying a description and full specifications of its new four-ton gasoline locomotive.

Vibration Insulation—A new catalog entitled "How to Isolate Machine Vibrations" has been issued by the Korfund Company, 11 Waverly Place, New York.

The Market Report

Metal Markets Continue Dull

Copper Strengthened, Then Returned to 14.25c. Delivered—Middle-West Lead Cut to 8.75c.—Zinc Recovers Somewhat

New York, Feb. 24, 1926—Little life has been exhibited by any of the non-ferrous metal markets during the last week. Volume of business has been small, and copper and lead prices are a trifle lower today than a week ago. Zinc, on the other hand, has recovered from the slump that took it suddenly from 7.70c. to 7.425c. last Thursday. Sellers generally are in a good position and are not forcing metal on an unwilling market. Tin has been steady, whereas silver touched new low prices for the year. The official price of platinum has been cut from $115 to $112 per ounce for refined metal.

Copper Sales Small

The volume of domestic copper business is still small, though last week was considerably better than the preceding one. On Friday two large lots were sold in the West at 14.375c. delivered, and on both Friday and Saturday fair tonnages were sold at the same figure in the Connecticut valleys. On Tuesday 14.30c. and 14.325c. were realized in the East. At the same time, however, some large sellers accepted 14.25c. on each of these days. Though a number of producers are nominally at 14.375c. today, a moderate supply of metal seems to be available at 14.25c. There is little pressure to sell, nor are consumers anxious to buy at the moment, but a renewal of buying activity is expected, as underlying conditions appear to continue good. Buying abroad is in only moderate volume at 14.50c. c.i.f., or about 14.25c. f.a.s.

Lead Slightly Weaker

Though a small accumulation of orders came to producers on Tuesday, the market for the week may be said to have been characterized by a pre-holiday quietness followed by a post-holiday dullness. The London market held steady all week, and prices in the East have changed little. There has been somewhat more of a tendency to quote low prices on forward deliveries against foreign ore lead, some May lead having been sold as low as 9c., New York, but the official price of the American Smelting & Refining Co. continues at 9.15c., and that level has been realized on a few small sales of spot metal and on a little business booked in the East by Middle Western producers. Foreign bullion lead is hardly salable in the domestic market at present levels.

Prices have been cut further in the Middle West by one of the large producers who desires to stabilize the market if possible and to establish a St. Louis price enough below that of New York, so that competition in the East can be met. A fair tonnage of March lead has therefore been sold in the last two days at 8¾c., St. Louis. Other producers are likely to meet this quotation, though so far they have been nominally ten or fifteen points above. For prompt deliveries, close to 9c. would have to be paid, in all probability, though there is little demand, most consumers apparently having their current requirements well covered.

Lead consumption continues excellent in the United States, especially with the battery and cable makers, but it is not so satisfactory in Europe.

Zinc Back to 7.75c.

Zinc appears to have recovered from the slump that took it to 7.40@7.45c. last Thursday, excellent sales being made on Saturday and yesterday at 7.70c. and 7.75c. The probability is that the decline was unwarranted. At the same time the price of ore in Joplin has declined to $49, thereby indicating a possibility of over-supply of the metal in the present state of the market. Rumors from several directions indicate the probability of curtailment at the mines for the purpose

Daily Prices of Metals

Feb.	Copper N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
18	14.00	63 25	64.375	9.10@9.15	9.00	7.40@7.45
19	14.025	63.125	64.25	9.10@9.15	9.00	7.45@7.50
20	14 05	63.125	64.25	9.10@9.15	9.00	7.70@7.75
22	Holiday	.....	.....	.....	.....	.....
23	14.025	63.625	64.75	9.10	8.75@8.85	7.70@7.75
24	14.00	63.375	64.375	9.10	8.75@8.80	7.75
Av.	14.020	63.300	64.400	9.115	8.915	7.620

*The prices correspond to the following quotations for copper delivered: Feb. 18, 14.25c.; 19th, 14.275c.; 20th, 14.30c.; 22nd (Holiday); 23rd, 14.275c.; 24th, 14.25c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Feb.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
18	59¼	60¼	66½	289¾	282½	33⅜	33 13/16	35 3/16	35¼
19	59⅜	60⅜	66½	290¼	282¼	33 15/16	34 1/16	35½	35 9/16
22	59½	60½	66½	291½	282⅜	33⅞	34	35⅝	35 13/16
23	59⅞	60⅞	66½	294⅜	283¾	33¾	33 15/16	35¾	35 13/16
24	59⅝	60⅝	66½	293¼	283¼	33¾	33 15/16	35¾	35 13/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Feb.	Sterling Exchange "Checks"	Silver		Gold London	Feb.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
18	4.85⅞	66½	30⅝	84s11¼d	22	Holiday	...	30⅝	84s11½d
19	4.85⅞	66¾	30¾	84s11½d	23	4.85¾	66½	30⅝	84s10d
20	4.85⅞	66⅜	30⅝	.....	24	4.85¾	66½	30 11/16	84s11½d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths cent premium.

of readjusting the position. Consuming inquiry is not much in evidence, galvanizers being particularly reluctant to place orders. In some quarters it is maintained that the premium for Brass Special is actually less than the usual 10 points, as a consequence of a surplus of this grade. High Grade is easier at 9c. to 9.25c. delivered New York.

Tin Holds Above 64c.

The tin market has been dull all week, consumers showing little interest except for urgent current requirements, at the present level of prices. The price fluctuation has been narrow since last Wednesday, varying between 64¼ and 64¾c. for prompt Straits, with May shipment ruling about 1½c. less.

Silver Lower

During the last week, both London and New York silver touched new low prices for the year, although some improvement has occurred since, based on moderate buying for account of China and India. The market is reported steady in London, and such seems to be the situation here, although indications for any future movement are lacking.

Mexican Dollars: Feb. 18th, 51c.; 19th, 51⅛c.; 20th, 51c.; 22d, Holiday; 23d and 24th, 51⅛c.

Foreign Exchange Slightly Weaker

Francs, lire, and sterling are fractionally lower than a week ago. Closing cable quotations on Tuesday, Feb. 23, were: francs, 3.63c.; lire, 4.02c.; and marks, 23.81c.; Canadian dollars continue at ⅜ per cent discount.

Correction — Sterling exchange on Feb. 11 was $4.85⅞ instead of $4.86 as published in the Feb. 20 issue.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

Aluminum—99 per cent grade, 28c. per lb.; 98 per cent, 27c. London, 98 per cent, £118 per long ton.

Antimony—Per pound, duty paid, New York: Chinese brands, spot, 21½c. March arrival, 19½@20c. Cookson's "C" grade, spot, 23¾c. Market quiet but firm.

Bismuth—$3.30@$3.35 per lb., in ton lots. London, 12s. 6d.

Cadmium—60c. per lb. Market slow. London, 1s. 9d. for Australian metal.

Iridium — $300@$325 per oz. for 98@99 per cent. Nominal. London, £70@£75 for 99.5 per cent.

Nickel—Ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent); London, £170@£175 per long ton.

Osmium—$90@$95 per ounce; London, £23½@£25½.

Platinum — $112 per ounce refined officially quoted. Sales also at $107@$110. Crude, $107@$108. London, £23@£24 for refined; crude, £21@£22.

Quicksilver—Per 75-lb. flask: $87.50@$88 for spot and forward. Quicksilver in Europe is bringing prices above domestic parity on strong support from the Orient. San Francisco, $88.67. London, £15.

Ruthenium — $90@$95 per ounce; London, £16½@£19½.

The prices of **Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Palladium, Radium, Rhodium, Selenium, Tellurium, Thallium, Tungsten,** and **Zirconium** are unchanged from the issue of Feb. 6.

Metallic Ores

Tungsten Ore—Per unit of WO_3, N.Y.: Wolframite, $12@$12.50; Western scheelite, $12.50@$13. Domestic demand very light, and prices largely nominal. European demand fair.

Chrome Ore, Galena and Pyrite Radio Crystals, Iron Ore, Manganese Ore, Molybdenum, Tantalum, and **Vanadium Ores** are unchanged from quotations in the Feb. 6 issue.

Lead Ore Unchanged—Zinc Blende Lower

Joplin, Mo., Feb. 20, 1926

Zinc Blende

	Per Ton
High	$58.20
Premium blende, basis 60 per cent zinc	$50.00@$51.00
Prime Western, basis 60 per cent zinc	$49.00
Fines and slimes, basis 60 per cent zinc	$48.00@$46.00
Average settling price, all zinc	$53.02

Galena

High	$118.25
Basis 80 per cent lead	$117.50
Average settling price, all lead	$115.32

Shipments for the week: Blende, 20,874; Lead, 2,624 tons. Value, all ores the week, $1,408,590.

There is no previous record in the history of the district when zinc blende was in such strong demand, with no visible stocks, and the price continuing to lower week after week, as it has this year. Stocks are low and all sold, with purchases being made on advance production, and yet the price continues to drop. The explanation offered is an overproduction of slab zinc, which has reacted on the price of the concentrate.

Lead concentrate has declined $5 from the high basis price this year, and it is estimated there are 10,000 tons withheld from sale.

Production is now estimated at 20,000 tons of blende per week and slightly more than 3,000 tons of lead. With an exception of one short period of zero weather the winter has been remarkably dry and warm, and this has made it possible to speed development of new mines and the construction of new mills, until a total of 185 mills are now in operation. A few have ceased overtime work, thus preventing a heavier production.

Platteville, Wis., Feb. 20, 1926

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$52.50
Lead Ore	
Lead, basis 80 per cent lead	$117.50

Shipments for the week: Blende, 1,072 tons; lead, 40 tons. Shipments for the year: Blende, 6,612; lead, 220 tons. Shipments for the week to separating plants, 1,856 tons blende.

Non-Metallic Minerals

Amblygonite, Andalusite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Ilmenite, Iron Oxide, Lepidolite, Limestone, Magnesite, Manjak, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Rutile, Silica, Spodumene, Sulphur, Talc, Tripoli, and **Zircon** are unchanged from prices in the Feb. 6 issue.

Mineral Products

Arsenious Oxide (White arsenic)—3@3½c. per lb. Nominal. London, £14@£15 per long ton.

Copper Sulphate, Sodium Nitrate, Sodium Sulphate, and **Zinc Oxide** are unchanged from prices in the Feb. 6 issue.

Ferro-Alloys

Ferrocerium, Ferrochrome, Ferromanganese, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and **Ferrovanadium** are unchanged from prices in the Feb. 6 issue.

Metal Products

Rolled Copper—Sheets, 22¾c.; wire, base price, 16c. per lb.

Lead Sheets—Full, 13c. per lb.; cut, 13¼c.

Nickel Silver—29¾c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal — Dimension sheets, 20¾c. per lb.; rods, 17¼c.

Zinc Sheets—12c. per lb., f.o.b. works.

Refractories

Chrome Brick, Firebrick, Magnesite Brick, Silica Brick, and **Zirkite** are unchanged from prices in the Feb. 6 issue.

Steel Steady—Pig Iron Dull—Coke in Increased Demand

Pittsburgh, Feb. 23, 1926

Steel mills are operating at approximately the same rate as in the last three months. Accumulation of shipping orders with which some of the mills entered the year is exhausted, but there has been a steady, though not sharp, increase in buying and specifying, whereby there is now nearly a balance between incoming and completed business.

All the steel-consuming industries are running well except for seasonal quietness and for the automobile trade, which, though picking up, is not doing as well as expected.

Structural steel business has run a trifle light in the last fortnight.

Efforts are being made to stiffen prices in the two lines, sheets and plates, which have lately developed weakness, though neither line had gone to levels prevailing before the November advances.

Pig Iron—The slump in the coke market due to the anthracite settlement gives pig iron consumers occasion for delay in making commitments. The market remains dull with prices unchanged: Bessemer $21; basic, $20; foundry, $20.50, f.o.b. Valley furnaces.

Connellsville Coke—In the latter part of last week a trading level was found, at $3.75@$4 for straight furnace, $5@$5.50 for yard crushed, and $5@$5.50 for foundry.

Zinc Market May Puzzle Both Consumers and Producers

By A. J. M. Sharpe
Foreign Correspondent, American Zinc Institute

IN MY SURVEY a month ago I ventured the prediction that 1926 would witness more violent price fluctuations than usual. At that time slab zinc was selling on the London market at over £39 per ton, whereas recently the quotation has fallen back to almost £36. If this market movement is to be a forerunner of what may be expected this year, then 1926 will be a difficult period for both producer and consumer—for the former inasmuch as he will be called upon to exercise close discrimination in the purchase of ore other than that based upon average metal prices and in selling his forward production, and consumers will be equally puzzled in deciding when to buy and when not to enter the market.

I do not expect world production to run much, if anything, above consumption this year, so that if there comes a time when the St. Louis and London markets are at parity it will make for considerable arbitrage business. For some time now, however, the European and American markets have not run interdependently. London has not been influenced by the strength of the American market, for the reason that, owing to the depression in Germany, she has been able to supplant the tonnage of United States zinc previously imported by an equivalent of Polish and German metal. The St. Louis market, in its turn, has been fortified by an advance in domestic consumption with which it did not catch up until December. Now, however, that the United States output is larger than required to meet domestic needs, it follows that if it be continued at the enhanced level the price must recede to nearer the London parity.

Statistically, the position of zinc remains very sound, and I am still of the opinion that producers the world over may, on the whole, look forward to another good year. I do not expect any further increase in European production, so that it largely remains a question of how long the present depressed state of affairs in Germany is to continue. There are at the time of writing some first signs of a business revival, and, although the recovery may be slow, it is reasonable to suppose that ere many months have passed Germany may again be consuming the whole of the Silesian zinc output and consequently compelling England to import American Prime Western.

My estimate of world stocks of zinc on Feb. 1 is as follows:

Country	Metric Tons
United States	12,900
Germany and Poland	7,200
Canada	1,600
Great Britain	500
Belgium	1,900
France	1,000
Scandinavia	200
Australia (including unsold shipments afloat)	2,000
Far East	500
Elsewhere	500
Total	28,300

A paper recently read by Gilbert Rigg before the Institution of Mining and Metallurgy, discussing possible improvements in the metallurgy of zinc, and the subsequent discussion thereon, prompt me to forecast at the beginning of the year that in 1926 there may conceivably be introduced important improvements in smelting practice. First, there is the Ashcroft process, aptly named "New Metallurgy," based on the old discovery that lead and zinc sulphide ores are completely attacked by chlorine at 600 deg. C., with disengagement of elemental sulphur, and that the resulting chlorides may be electrolyzed. Successful electrolysis of zinc and lead chlorides in a state of fusion in a multiple cell (self-heating apparatus) is the key to the whole of the system known as "New Metallurgy," or the pyro-electric process as distinguished from hydro-electric. An English company has been formed to build and equip a working unit with a capacity of ten tons of ore daily to demonstrate the claims that 99.5 per cent of lead and silver and 99 per cent of zinc as well as the sulphur are recovered from sulphides at a cheaper net cost than in any existing treatment method.

The Coley zinc process will also be proved or disproved in the next twelve months, as a company has been formed under good auspices for the purpose of trying out the method in a plant with a capacity of ten tons of ore daily.

A third process, under development in England, is the invention of Frank Elmore, but the company which owns the patent rights has been working so long on the job that the enthusiasm of the majority of its supporters has been damped, and the inference is that the difficulties surrounding this particular method have not yet been wholly surmounted.

Another method for the recovery of zinc, the fourth here presented for consideration, and one which holds considerable promise for the treatment of calamines, is that known as the Waelz process. Originally intended for employment in producing zinc oxide direct from ore, steps are now being taken to try it out on the treatment of sulphide ores also.

Company Reports

Wright-Hargreaves Had Best Year in 1925

During 1925 Wright-Hargreaves Mines, Ltd., producing gold in the Kirkland Lake district, Ontario, experienced the best year in its history. The financial statement for the year's operations follows:

Profit-and-Loss Account Jan. 1, 1925, to Dec. 31, 1925

Bullion production			$1,913,401.82
Operating costs			
Development and exploration	$111,371.42		
Stoping	196,140.73	$307,512.15	
Transporting ore (hoisting and similar work)		93,357.42	
Milling charges		171,487.80	
Marketing bullion		14,485.68	
General and undistributed charges		74,667.36	
Depreciation plant and equipment		79,420.82	740,931.23
From operation			$1,172,470.59
Other income			
Exchange		260.73	
Interest		31,487.48	
Rent, cottage operation and materials		4,194.67	
Purchase discounts earned		492.11	
Miscellaneous		739.00	37,173.99
Net to surplus			$1,209,644.58

In his annual report James E. Grant, general manager, says that during the year 147,939 tons of ore was treated and the bullion recovered amounted to $1,913,401.82, with an average value per ton of $12.93. The mill operated 89.05 per cent of its possible running time, and treated on an average of 402 tons per day, an increase of 172 tons per day over the same period of a year ago. Operating costs are reproduced below:

Description	Totals	Cost Per Ton Milled
Development and exploration	$111,371.42	0.753
Stoping	196,140.73	1.326
Transporting ore (hoisting and similar work)	93,357.42	0.631
Milling charges	171,487.80	1.159
Marketing bullion	14,485.68	0.098
Administration, taxes and other charges	74,667.36	0.504
Depreciation plant and equipment	79,420.82	0.537
	$740,931.23	$5.008

During the year No. 1 shaft was sunk from the 700 level to a depth of 1,271 ft. At this point the ore is in the shaft and is of a good grade. During the development work on No. 1 vein, ore has been opened up on the 400, 700, 850, and 1,125 levels.

During the latter part of November an additional compressor was installed, delivering 1,000 cu.ft. of air per minute, at 100 lb. pressure, and accordingly, during the month of December more machines were added underground, greatly increasing development. An electric hoist was also installed underground for shaft sinking, having a hoisting capacity of 3,000 lb. at 300 ft. per minute. During the month of March milling capacity was stepped up to 400 tons per day. This tonnage was consistently maintained throughout the year, with the result that the average tonnage treated per day for the year was 172 tons greater than in 1924.

Nevada "Con" Production and Earnings Show Increase

The report of the Nevada Consolidated Copper Co. for the fourth quarter of 1925 shows a net production of refined copper amounting to 19,555,262 lb., compared with 17,595,334, 18,218,132, and 18,285,158 lb., successively, in the first three quarters. A total of 594,835 tons dry weight of Nevada Consolidated ore, averaging 1.47 per cent copper, and 433,254 tons dry weight of pit strippings, averaging 0.69 per cent copper, were concentrated. A total of 5,371 dry tons of Ruth mine direct-smelting ore, averaging 2.61 per cent copper, was shipped. Average recovery at the concentrator was 91.99 per cent, making for an extraction of 27.01 lb. of copper per ton of ore, compared with 92.01 per cent and 22.66 lb., respectively, for the third quarter.

The milling of the pit strippings resulted in an average recovery of 81.22 per cent, corresponding to 11.18 lb. of copper per ton, compared with 81.05 per cent, or 10.96 lb. of copper per ton, of similar material treated during the preceding quarter. As the copper content of this material exists largely in the form of sulphides and can be saved by present concentrating methods, as described in the last quarterly report, this treatment continues to prove economically advantageous. The cost per pound of net copper produced from all sources, including charges for depreciation of plant and equipment and all fixed and general expenses and after crediting gold and silver and miscellaneous earnings, was 10.15c., compared with a cost, similarly computed, of 10.81c. per pound for the preceding quarter.

The financial outcome of operations is exhibited in the statement below, set out in comparison with the results of the three preceding quarters:

	1925		
	Fourth Quarter	Third Quarter	Second Quarter
Operating gain from copper production	$683,870.11	$480,908.05	$430,709.77
Gold and silver and miscellaneous earnings	290,768.46	207,980.63	195,570.30
Nevada Northern Railway dividend	75,000.00	75,000.00	75,000.00
Total income	$1,049,638.57	$763,888.68	$701,280.07
Plant and equipment depreciation	167,862.51	167,862.51	167,862.51
To surplus	$881,776.06	$596,026.17	$533,417.56

Earnings as above set forth are computed on the basis of an average carrying price of 14.27c. per pound of copper for the current quarter, as against 14.07c. and 13.51c., respectively, for the third and second quarters.

American Metal Co. Netted $3,353,866 During 1925

The improved market for all the products of the American Metal Co. during the greater part of 1925 influenced the management to make liberal appropriations for enlargement of existing facilities and active exploration of new properties now under option or which have been acquired. In consequence, says the annual report, new units are being added both in this country and in Mexico which during the period of exploration have been an expense, but ultimately should prove a source of revenue.

United Verde Extension Operated Steadily Throughout 1925

The report of the United Verde Extension Mining Co., operating in the Jerome district in Arizona, shows that operations were continuous both in the mine and at the smelter during 1925. The output was as follows:

	Tons	Copper, Per Cent	Gold, Oz.	Silver, Oz.
Ore mined	186,008	11.51	0.046	2.33
Ore smelted	180,763	11.53	0.046	2.34
Custom concentrates smelted	2,546	6.40	0.331	17.19
Ore shipped	4,170	7.26	0.048	4.02
Copper produced, lb.				43,720,324
Copper sold, lb.				43,853,314

Development work in the upper levels to the westward has developed a body of high-grade ore on the 800 level which at present is most promising, but as yet sufficient work has not been done to prove its extent.

The table below shows the average cost per pound of copper during the year; not including (1) depreciation, (2) reserve to return capital (depletion), (3) taxes.

Mining	$0.0246
Smelting	0.0232
Freight on ore	0.0008
Freight on bullion, refining and selling	0.0180
Other expenses	0.0027
	$0.0693

During the year 1925, the company made quarterly distributions to its stockholders aggregating $2.25 per share. Of this amount 9.69 per cent, or 21.8c. per share, was paid out of earned surplus, and 90.31 per cent, or $2.03 2/10 per share, was paid out of depletion reserve account, as shown in the balance sheet.

In the opinion of the officers and counsel of the company, these distributions from depletion reserve account are controlled by Article 1546, of Regulations 65, under the Revenue Act of 1924, and should be considered as a return of capital up to the cost of the stock held. If the full cost of stock has not been returned to the stockholder in these or other depletion distributions, the distributions amounting to $2.03 2/10 per share in 1925 are, in the opinion of the company officials, free from income tax.

Statement of Earnings for Year Ended Dec. 31, 1925

Gross revenue from metals and ore produced		$6,706,647.05
Other revenue		280,897.15
		$6,987,544.20
Deductions		
Mine and smelter operating, freight, refining and selling expenses	$2,984,071.60	
Other expenses	652,138.68	
		3,636,210.28
Earnings from operations		$3,351,333.92
Less		
Amounts written off to reserves		
For depletion	$2,395,235.27	
For depreciation	579,678.10	
		2,974,913.37
Net profit to surplus		$376,420.55

Consolidated Surplus Account, American Metal Co. and Subsidiaries for Year Ended Dec. 31, 1925

Surplus at beginning of year			$9,264,945.67
Income from operations during year after deducting management's share of profits under contract and provision for United States and Mexican federal income taxes, but before depreciation, deducted below		$5,296,109.21	
Less depreciation, depletion, exploration expenses, extraordinary repairs, and obsolescence	$1,606,956.02		
Special provisions for reduction of values of investments and inventories	335,287.14		
		1,942,243.16	
Net income		$3,353,866.05	
Surplus of subsidiaries transferred to ordinary reserves in accordance with requirements of Mexican law		35,042.26	
		$3,318,823.79	
Additions to consolidated surplus through acquisitions of stocks of subsidiaries		41,175.18	
		$3,359,998.97	
Less dividends			
Preferred, $7 per share on 50,000 shares	$350,000.00		
Common, no par value stock, at the rate of $3.25 per annum on 591,593 shares and on additional shares as issued	1,926,775.00		
		2,276,775.00	
Balance added to surplus			1,083,223.97
Surplus at Dec. 31, 1925			$10,348,169.64

Current Prices of Mining Supplies

Rise and Fall of the Market

THE current market is higher than a month ago in track supplies, steel plates, cut nails and rope. A downward tendency is noted in steel sheets and linseed oil. In the St. Louis district the decline affected c.-i. pipe and hollow tile. Pine lumber remains firm while an easier tone prevails in the market for Douglas fir.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.40@2.50	$3.60	$3.50	$3.75	$3.89
Black No. 28	3.25@3.35	4.60	4.10	4.80	4.50
Galvanized No. 28	4.50@4.60	5.70	5.25	6.00	5.50

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots:

	Pittsburgh Current	Pittsburgh One Year Ago	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00
Standard openhearth rails	43.00	43.00	43.00	43.00

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Current	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80	$2.90	$3.55	$3.65	$4.35	$3.00
Track bolts	3.90@4.25	3.90@4.25	4.55	4.40	5.35	3.90
Standard section angle bars	2.75	2.75@2.85	3.40	3.25@3.75	4.00	4.15

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.90@2.00	$2.05	$3.34	$4.15	$3.25	$3.10	$3.30
Channel, 3 to 15 in.	1.90@2.00	2.10	3.34	4.15	3.25	3.10	3.30
Angles, 3 to 6 in., ¼ in. thick	1.90@2.00	2.10	3.34	4.15	3.25	3.10	3.30
Tees, 3 in. and larger	1.90@2.00	2.10	3.34	4.15	3.35	3.10	3.30
Plates	1.80@1.90	2.00	3.34	4.15	3.25	3.10	3.30

WIRE ROPE—Discounts from list price, f.o.b. New York and east of Missouri River, on regular grades of bright and galvanized are as follows:

Cast steel round strand rope	20%
Galvanized steel rigging and guy rope	7½%
Round strand iron and iron tiller	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%
Galvanized iron rigging and guy rope	+12½%

	New York	Cleveland	Chicago
Drill Rod (from list)	50@60%	55%	60%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

	Steel Inches	Steel Black	Steel Galv.	Iron Inches	Iron Black	Iron Galv.
BUTT WELD—	1 to 3	62	50½	1 to 1½	30	13
LAP WELD—	2½ to 6	59	47½	3 to 6	28	13

STEEL PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black New York	Black Chicago	Black St. Louis
2½ to 6 in. lap welded	48%	51%	46%

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York Current	New York One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
6 in. and over	$50.60@52.60	$54.60@55.60	$41.00 @ 42.00 base	$50.20@51.20	$47.60	$51.00

NUTS—Semi-finished, ½x½-in., 2c. each. Discount 70% for ⅜-in. and smaller; 65% for ½-in. and larger. Case hardened, 6c. each, less 50%.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York Current on Trucks	New York One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory
4x12x12	$0.1112	$0.1162	$0.075	$0.12	$0.07	$0.108	.....
6x12x12	.1667	.1743	.09¢	.....	.094	.156	$0.252*
8x12x12	.2084	.2179	.135	.22	.128	.244	.312†

* 10x12x12; † 12x12x12.

MACHINE BOLTS—½x1½-in., per 100, $1.70. Discount at New York warehouses on all sizes up to 1x30-in., 40%.

LUMBER—Prices of rough Douglas Fir No. 1 common, in carload lots to dealers at yards in San Francisco. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00

Wholesale prices to dealers of long leaf yellow pine. To contractors in New York City, delivered from lighters or cars to job, $5 additional.

	New York 20 Ft. and Under	New York 22-24 Ft.	Chicago 20 Ft. and Under	Chicago 22-24 Ft.
3x4 to 8x8	$47.00	$48.00	$42.00	$43.00
3x10 to 10x10	52.00	53.00	47.50	48.50
3x12 to 12x12	58.00	59.00	57.50	58.50

Other Cities	8 x 8-In. x 20 Ft. and Under Pine	Fir*	Hemlock	Spruce	12 x 12-In. 20 Ft. and Under Pine	Fir*
Boston	$51.00	$48.00†	$51.00	$50.00	$61.00	$58.00†
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Denver	.....	32.75	33.75	33.75	.....	49.50
Minneapolis	42.00	37.75	35.00	.....	44.50	37.75
Kansas City, Mo.	44.50	40.75	.....	.....	59.50	41.00
Philadelphia	54.00	34.00	37.00	43.00	65.00	34.00

*Douglas fir. † Prime.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.65	$3.15	$3.40	$4.25	$2.93	$4.95
Cut	2.80	.....	5.00	5.00	3.15	5.00

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots *without bags*. Cash discount not deducted.

	Current	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.70	$2.50@2.70	$2.50@2.60
Chicago, f.o.b.	2.10	2.10	2.20
Cleveland, f.o.b.	2.29	2.29	2.39

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	280-lb. net Common
New York	$18.20	$12.@13.10	$3.50	$2.25@$2.75
Chicago	20.00	18.00	.....	2.20

LINSEED OIL—These prices are per gallon:

	New York Currant	New York One Year Ago	Chicago Current	Chicago One Year Ago
Raw in barrel (5 bbl. lots)	$0.87½	$1.26	$0.88	$0.94

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry Current	Dry 1 Yr. Ago	In Oil Current	In Oil 1 Yr. Ago
Red	15.25	16.25	16.75	17.75
White	15.25	16.25	15.25	16.25

HOSE—Quotations at New York warehouses:

Fire Protection — 50-Ft. Lengths

Underwriters' 2½-in. coupled, single jacket ..... 71c per ft.

Air—Best Grade

¾-in., per ft. ..... 3 ply $0.37½ 4 ply $0.46

Steam—Discounts from List

First grade ..... 30–10% Second grade ..... 40% Third grade ... 40–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. for rubber transmission belting.

Best grade ..... 50% Second grade 50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses:

Grade	Discount from list
Medium	40–5%
Heavy	30–10%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ⅛ in.	$1.05
Rubber sheet	.60
Rubber sheet, wire insertion	.85

MANILA ROPE—Per lb., ¾-in. and larger, 1,200-ft. coils.

Atlanta	$0.27	New Orleans	$0.25½
New York	.27	Seattle	.24
Chicago	.25½	San Francisco	.25

EXPLOSIVES—Prices per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265	$0.2875
Minneapolis	.1917	.2123
Denver	.2025	.2275
Seattle	.165	.19
Cincinnati	.22	.245
New Orleans	.233	.26
San Francisco	.1625	.1925

FLOTATION OIL—

Pine tar, 50 gal. bbl., gross weight 500 lb., f.o.b. New York, carload lots, per gal. $0.38

CHEMICALS—

Zinc dust, 550 lb. casks, f.o.b. works, per lb.	$0.09@.10
Litharge, f.o.b. New York, kegs, per 100 lb.	15.25
Sodium cyanide, 220 lb. single case lots, f.o.b. works, per lb.	18@.22
Calcium carbide, in drums, f.o.b. works, per lb.	.05½@.06

Mining Stocks—Week Ended February 20, 1926

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	49⅛	48	48⅛	Ja.16,Fe.23,Q	0.75
Arcadian Consol.	Boston	*65	*50	*50		
Ariz. Com'l	Boston	12⅛	11⅛	12	Jy.21, Jy. 31 SA	0.50
Calaveras	N. Y. Curb	3¼	3⅛	3⅛		
Calumet & Arizona	New York	62	59⅛	60⅞	De.4, De.21 QX	1.50
Calumet & Hecla	Boston	15⅛	14⅛	14⅛	Nov.30,De.15 Q	0.50
Cerro de Pasco	New York	67⅛	65⅛	66¼	Ja. 14, Fe. 1, Q	1.00
Chile Copper	New York	35⅛	34⅛	35	Ma.3,Ma.29,Q	0.62½
Chino	New York	21½	21	21½	Sept., 1920	0.37½
Con. Coppermines	N. Y. Curb	1⅛	1⅛	1⅛		
Copper Range	Boston	19½	18⅛	18⅛	May, 1925	1.00
Crystal Copper	Boston Curb	*47	*45	*46		
East Butte	Boston	4	3⅛	3⅛	Dec., 1919	0.50
First National	Boston Curb	...	...	*20	Feb., 1919	0.15
Franklin	Boston			*80		
Granby Consol.	New York	22	20½	21⅛	May, 1919	1.25
Greene-Cananea	New York	13	12	12⅛	Nov., 1920	0.50
Hancock	Boston	*80	*80	*80		
HoweSound.new,r.t.c.	New York	33⅛	31	32⅛	Ja. 5, Ja. 15 Q	0.50
Inspiration Consl.	New York	25⅛	24⅛	25⅛	De.17, Ja.4, Q	0.50
Iron Cap	Boston Curb	3⅛	2⅛	2⅛	May, 1923	0.15
Isle Royale	Boston	12⅛	12	12	No.30, De.5	1.00
Jerome Verde Dev.	N. Y. Curb	*1⅛	*1⅛	*1⅛		
Kennecott	New York	57⅛	55⅝	56⅛	Ma.5,Ap.1 Q	1.00
Lake Copper	Boston	1¼	1⅛	1⅛	June, 1925	0.50
Magma Copper	New York	44	42⅛	43⅛	De.31, Ja.15,	0.75
Mason Valley	N. Y. Curb	2¼	2⅛	2⅛		
Mass Consolidated	Boston	*60	*51	*51	Nov., 1917	1.00
Miami Copper	New York	12⅞	12⅛	12⅛	Feb.1, Feb.15 Q	0.25
Mohawk	Boston	34⅛	34	34	Jan. 30, Ma.1 Q	1.00
Mother Lode Coa.	New York	7⅞	7	7⅛	De. 11, De. 31	0.37½
Nevada Consol.	New York	14	13⅛	13⅜	De. 18, De.31 Q	0.25
New Cornelia	Boston	21	20⅛	20⅛	Fe.5, Fe.23 Q	0.30
North Butte	Boston	3⅛	2⅛	2⅛	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*67	*63	*67	No. 14, De. 2	0.05
Old Dominion	Boston	18⅛	17⅛	18⅛	Dec., 1918	1.00
Phelps Dodge	Open Mar.	†135	†132	....	De.21, Ja.2 Q	1.00
Quincy	Boston	21	19⅛	20⅛	Mar., 1920	1.00
Ray Consolidated	New York	12⅛	12⅛	12⅛	Dec., 1920	0.25
Ray Hercules	N. Y. Curb	...	...	11⅛		
St. Mary's Min. Ld.	Boston	35⅛	34	35	May, 1925	3.00
Seneca Copper	New York	8⅛	8	8		
Shannon	Boston	*65	*60	*60	Nov., 1917	0.25
Shattuck Arizona	New York	65	58	58⅛	Jan.,1920	0.25
Superior & Boston	Boston	1	*90	*95		
Tenn. C. & C.	New York	15⅛	14⅛	14⅛	Fe.27,Ma.15,Q	0.25
United Verde Ex.	N. Y. Curb	32	30½	30½	Ja.5, Fe.1, Q	0.75
Utah Copper	New York	104	103	103	De.18, De.31,Q	1.25
Utah Metal & T.	Boston	1⅛	1⅛	1⅛	Dec., 1917	0.30
Victoria	Boston	*60	*60	*60		
Walker Mining	Salt Lake	1.27½	1.15	1.15		
NICKEL-COPPER						
Internat. Nickel	New York	43⅛	41⅛	41⅛	De.17,De.31,Q	0.50
Internat. Nickel, pfd.	New York	102	102	102	Ja.25, Fe.1, Q	1.50
LEAD						
Gladstone M. M. Co.	Spokane	*37	*36	*36½	Ja. 1, Ja. 10 M	0.0½
National Lead	New York	....	....	168	Ma.12, Ma.31 Q	2.00
National Lead pfd.	New York	166⅜	163⅛	166⅛	Aug.21, Se.15	1.75
St. Joseph Lead	New York	116	116	116	De.10,De.20 QX	1.50
ZINC						
Am. Z. L. & S.	New York	10⅛	9⅛	10	May., 1920	1.00
Am. Z. L. & S, pfd.	New York	42⅛	40⅛	41	Nov., 1920	1.50
Butte C. & Z.	New York	6⅛	6	6	De.10, De.24	0.50
Butte & Superior	New York	15	14	14⅛	De.15, De.31 Q	0.50
Callahan Zn-Ld	New York	2⅛	2	2⅛	Dec., 1920	0.50
Eagle Picher	Cincinnati	33⅛	30⅞	31⅛	My. 15, Jn.1	0.40
Eagle Picher, pfd.	Cincinnati	...	...	110	Ja.1, 15.31	1.50
New Jersey Zn.	N. Y. Curb	...	...	208	Fe.lu, Fe.28 Q	0.90
United Zinc	N. Y. Curb	...	...	*70		
Yellow Pine	Los Angeles	*50	*27	*50	De.8, De.18 Q	0.04
GOLD						
Alaska Juneau	New York	1⅜	1⅛	1⅛		
Argonaut	Toronto	*44⅛	*40	*40¼		
Barry-Hollinger	Toronto	*46	*43	*46		
Carson Hill	Boston	*45	*45	*45		
Consol. W. Dome L.	Toronto	*28	*24	*24½		
Cresson Consol. G.	N. Y. Curb	2⅛	2⅛	2⅛	De.31, Ja. 7	0.10
Crown Reserve	Toronto	*22½	*19½	*19½	Jan., 1917	0.05
Dome Mines	New York	19⅛	18⅛	19	De.31, Ja.20, Q	0.50
Golden Center	N. Y. Curb	2	1⅛	1⅛		
Golden Cycle	Colo. Springs	†1.55	†1.54	....	No.30, Dec.10 Q	0.03
Hollinger Consol.	Toronto	19.85	18.85	18.90	Fe. 9, Fe. 25	0.08
Homestake Mining	New York	61	55	61	Fe.20,Fe.25 Mo	0.50
Kirkland Lake	Toronto	1.44	1.28	1.30		
Lake Shore	Toronto	12.50	11.80	11.99	Ma.1,Ma.15 Q	0.10
McIntyre-Porcupine	New York	30	26⅛	27⅛	Fe.1, Ma.7	0.05
Newray	Toronto	*43	*42	*43		
Night Hawk Pen.	Toronto	12	9½	9⅞		
Noranda	N. Y. Curb	17⅛	15⅛	16		
Portland	Colo. Springs	†*60	†*58⅛	....	Oct., 1920	0.01
Rand Mines	New York	....	....	34⅛	Fe.16, Fe.26	1.52
Teck-Hughes	Toronto	3.75	3.50	3.70	Ja. 15, Fe. 1	0.05
Tom Reed	Los Angeles	*55	*50	*52½	Ma.10Ma.20	0.02
Tough-Oakes	Toronto	*60	*53	*60		
United Eastern	N. Y. Curb	*43	*43	*43	July, 1924	0.05
Vipond Cons.	Toronto	1.95	1.80	1.85		
Wright-Hargreaves	Toronto	9.25	8.60	9.00	De.15, Ja. 1 QX	0.10
Yukon-Alaska Trust	N. Y. Curb	....	....	20½		
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	20¾	20	20½		
Con. Cortez	N. Y. Curb	*6	*6	*6		
Con. Virginia	San Francisco	*13½	*9½	*9½		
Continental Mines	N. Y. Curb	...	...	*45		
Dolores Esperanza	N. Y. Curb	*74	*74	*74	July, 1923	0.05
Premier Gold	N. Y. Curb	2 7/8	2⅛	2⅛	De.18, Ja. 4	0.08
Tonopah Belmont	N. Y. Curb	4⅛	4	4	Se.15, Oc.1	0.05
Tonopah Extension	N. Y. Curb	*65	*53	*55	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	7⅛	6⅞	7	Se.30, Oc.21	0.07½
Unity Gold	N. Y. Curb	...	...	*20		
West End Consol.	N. Y. Curb	*30	*24	*30	Mar., 1923	0.05
Yukon Gold	N. Y. Curb	...	...	*50	June, 1918	0.02

Stock	Exch.	High	Low	Last		Last Div.
SILVER						
Alvarado	N. Y. Curb	...	...	1	Oct., 1920	0.50
Beaver Consol.	Toronto	*98	*84	*86	May. 1920	0.03
Castle-Trethewey	Toronto	1.84	1.60	1.72		
Coniagas	Toronto	4.40	4.25	4.25	May, 1924	0.12½
Keeley	Toronto	1.76	1.69	1.70	Ma. 1,Ma.15 X	0.12
Kerr Lake	N. Y. Curb	1⅜	1⅛	1⅛	Oc. 1, Oc.15 Q	0.12½
La Rose	Toronto	*32	*30	*32	Apr., 1922	0.10½
Lorrain Trout Lake	Toronto	1.10	1.00	1.10	Jy. 2, Jy. 15	0.05
McKinley-Dar.-Sav.	Toronto			*23	Oct., 1920	0.03
Mining Corp. Can.	Toronto	4.40	2.00	4.40	Ja. 16, Ja.30	0.12½
Nipissing	N. Y. Curb	6⅜	6¼	6⅜	De.31, Ja.2, Q	0.15
Temiskaming	Toronto	...	...	13	Jan., 1920	0.40
SILVER-LEAD						
Ahumada	New York	8¼	8	8	De.15,Ja.2, X	0.25
Alta Merger	Salt Lake	†1¼	†1	....		
Bingham Mines	Boston	50⅜	50	50	Ma.20,Ma.31 Q	1.00
Cardiff M. & M.	Salt Lake	*56	*56	*56	De.16, No.18	0.10
Chief Consol.	Salt Lake	3.50	3.30	3.50	Fe. 1,	0.10
Emma Silver	Salt Lake	†3	†1	....		
Erupcion	Boston Curb	1⅜	1⅜	1⅜	De.15, Ja.2, X	0.10
Federal M. & S.	New York	97½	95	95		
Federal M. & S., pfd.	New York	90	87	90	No.25, De.15 Q	1.75
Hawthorne Mines	N. Y. Curb	*26	*16	*24		
Hecla Mining	N. Y. Curb	18⅛	17⅛	17⅛	Fe.15, Ma.15 Q	0.50
Iron King Mining	Salt Lake			*35		
Keystone Mining	Salt Lake	*60	*52	*52	Au.12, Au.26	0.07½
Lucky Jim	Spokane	*16½	*15½	*16½		
Mammoth Mining	Salt Lake	2.95	2.92½	2.95	De. 16, De. 23	0.10
Marsh Mines	Spokane	*8⅛	*7⅛	*7⅛	Se.15, Oc.1	0.15
Ontario Silver	New York	...	...	10		
Park Utah	Salt Lake	8.05	8.00	8.00	De.15, Ja.2	0.15
Prince Cons.	Salt Lake	*75	*50	*75		
Silver King Coal	Salt Lake	9.55	9.40	9.50	De.15, Ja.2, QX	0.35
Silversmith	Spokane	*46	*43	*46	De.31, Ja.10	0.02
Tamarack-Custer	Spokane	*55	*48	*48	Sept., 1924	0.25
Tintic Standard	Salt Lake	13.62½	13.62½	13.62½	De.16,De.23,QX	0.30
Utah-Apex	Boston	10⅛	9⅛	9⅛	Ja.1, Ja.5, Q	0.35
Western Utah Copper	N. Y. Curb	...	...	*8		
IRON						
Bethlehem Steel	New York	46⅞	42¾	43½	July, 1924	1.25
Colorado Fuel & Iron	New York	36¼	35	35¼	May, 1921	0.75
Gt. North'n Iron Ore	New York	...	...	27	De. 4, De. 28,	0.75
Inland Steel	New York	39	38	38	Fe.15, Ma.1 Q	0.62½
Mesabi Iron	N. Y. Curb	1⅜	1⅜	1⅜		
Replogle Steel	New York	13⅜	12⅛	12⅞		
Republic I. & S.	New York	56	52⅜	55⅛	May, 1921	1.50
Republic I. & S. pfd.	New York	94½	94	94⅜	Ma.15, Ap.1, Q	1.75
Sloss-Sheffield S. & I.	New York	127¾	122	127¾	De.10, De.21 Q	1.50
Sloss-Shef. S.&I. pfd.	New York	101	101	101	De.21, Ja.2, Q	1.75
U. S. Steel	New York	131⅛	128⅛	129⅜	Fe.27, Ma.30 XQ	1.75
U. S. Steel pfd.	New York	126⅛	126⅛	126⅛	Fe. 3, Fe. 27, Q	1.75
Virginia I. C. & C.	New York	43½	43	43	Jan., 1924	1.50
Virginia I.C.&C.pfd	New York	...	...	77	De.15, Ja.2,	2.50
VANADIUM						
Vanadium Corp.	New York	32⅜	31⅛	32⅛	Fe.1, Fe.15, Q	0.50
ASBESTOS						
Asbestos Corp.	Montreal	92	88	90⅛	De.31, Ja.15 Q	1.50
Asbestos Corp., pfd.	Montreal	115⅛	115	115	De.31, Ja.15, Q	1.50
SULPHUR						
Freeport Texas	New York	27	24⅛	25⅜	Nov., 1919	1.00
Texas Gulf	New York	142⅜	134	139⅛	Ma.1, Ma.15,Q	2.50
DIAMONDS						
De Beers Consol.	New York	...	...	29	Ja.26, Fe.2	0.23
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	4⅛	3⅞	4⅛		
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	57⅜	54½	54⅜	Fe.18, Ma. 1, Q	1.00
Amer. Metal pfd.	New York	119⅜	119	119½	Fe. 19, Ma. 1, Q	1.75
Amer. Sm. & Ref.	New York	139½	135	137⅛	Ja.15, Fe.1,	1.75
Amer. Sm.&Ref.pfd.	New York	115½	114⅞	115½	Fe.5,Ma .1, Q	1.75
Consol. M. & S.	N. Y. Curb	*50	*50	*50	De.31, Ja.15	0.75
Federated Metals	N. Y. Curb	20	20	20		
Newmont Mining	N. Y. Curb	57⅛	54⅛	54⅛	De.31, Ja.15,	0.60
Southwest Metals	N. Y. Curb			2		
U. S. Sm. R. & M.	New York	47⅜	46⅛	46⅞	Ja.1, Ja.7, Q	0.87½
U.S. Sm. R.&M.pfd.	New York	50	49⅜	50	Ja.1, Ja.7, Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange and Henry Sachs; Colorado Springs, Colo.

PRICE WEEK ENDED FEBRUARY 10, 1926

Name	High	Low	Last	Last Divd. Date	Amount
Aramayo Mines (25 frs.)	81/3	79/—	80/—	Feb. 1926	5 p.c.†
British Platinum (£1)	7/3	6/6	6/9	Feb. 1925	2½ p.c.
Burma Corpn. (10 rupees)	17/7½	16/4½	17/—	Feb. 1926	6 annas*
Bwana M'Kubwa (5s)	7/9	7/3	7/6		
Camp Bird (£1)	5/3	4/10½	5/1½		
El Oro (£1)	6/10½	6/—	6/9	Nov. 1924	2½ p.c.*
Esperanza (10s)	2/1½	1/9	2/—		
Frontino & Bolivia (£1)	8/9	8/—	8/9	Jan. 1926	1½ p.c.
Mexican Corpn. (£1)	22/—	20/6	21/3		
Mexico Mines of El Oro (£1)	37/6	36/10½	37/6	Dec. 1925	12½ p.c.*
Nechi (pref. 10s)	1/6	1/—	1/—	1921–22	25 p.c.
Oroville Dredgng (£1)	4/1½	3/10½	4/—	Dec. 1923	3½ p.c.
Ouro Preto (£1)	2/9	2/6	2/6	May 1925	2½ p.c.
St. John del Rey (£1)	11/—	10/1½	10/6	June 1925	6½ p.c.
San Francisco Mines (10s)	31/10½	30/4½	31/3	Jan. 1926	22½ p.c.
Santa Gertrudis (£1)	21/9	20/6	21/3	July 1920	5 p.c.
Selukwe (2s. 6d.)	11/7½	10/7½	11/—	April 1917	6¾ p.c.
S. Amer. Copper (2s.)	5/4½	4/9	5/3	Nov. 1917	75 p.c.
Tanganyika (£1)	47/—	43/1½	46/3	Sept. 1925	5 p.c.
Tomboy (£1)	3/9	3/6	3/9	Jan. 1926	5 p.c.
Union Miniere du Haut-Katanga (Brussels)	6.500	6.375	6.475	July 1925	150 frs.‡

* Free of British income tax. † Swiss frs. ‡ Belgian frs.